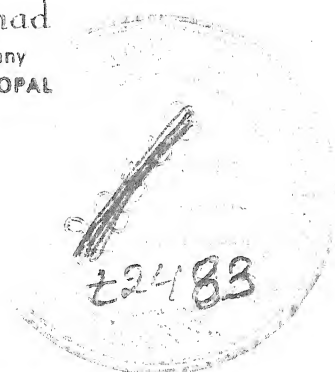


**A STUDY OF
THE TRICHOME STRUCTURE
AND ITS TAXONOMIC SIGNIFICANCE
IN THE FAMILY SCROPHULARIACEAE**

THESIS
SUBMITTED FOR THE DEGREE OF
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SUPERVISOR'S CERTIFICATE

It is herewith certified that the thesis entitled "A STUDY OF THE TRICHOME STRUCTURE AND ITS TAXONOMIC SIGNIFICANCE IN THE FAMILY SCROPHULARIACEAE" being submitted for the award of Ph.D. degree in Botany is a record of bonafide investigations carried out by Mr. Bashir Ahmad. He has worked for the period required under the University Ordinance No. 7.

It is also certified that the aforesaid subject was duly approved by the Research Degree Committee (Botany) of Bundelkhand University, Jhansi vide letter No. B.U./Res/85/20374-76 dated 21-11-85, and that with the exception of supervision and guidance received from the undersigned, this thesis embodies candidate's own unaided work and his original contribution which has not previously formed the basis for the award of any degree or diploma etc., elsewhere.

JHANSI

DATED : 23rd May, 1988.


(DR. D.P. MISHRA)

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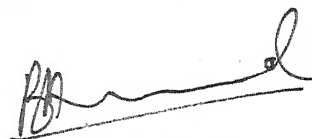
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C O N T E N T S

Page

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CHAPTER I	INTRODUCTION AND REVIEW OF LITERATURE	1 - 17
CHAPTER II	MATERIALS AND METHODS	18 - 26
CHAPTER III	STRUCTURE OF TRICHOME TYPES	.....	27 - 192
	a) Series - Pseudosolanaceae	.....	27 - 41
	b) Series - Antirrhinideae	.....	42 - 129
	c) Series - Rhinanthideae	.....	130 - 192
CHAPTER IV	OBSERVATION AND DISCUSSION	.....	193 - 259
	a) Series - Pseudosolanaceae	.....	193 - 205
	b) Series - Antirrhinideae	.....	206 - 237
	c) Series - Rhinanthideae	.....	238 - 259
CHAPTER V	GENERAL DISCUSSION	.....	260 - 281
CHAPTER VI	SUMMARY AND CONCLUSIONS	.....	282 - 295
	REFERENCES	.....	296 - 317
	APPENDICES : 1, 2 & 3	.....	318 - 325
	PHOTOPLATES: 52 - 60		

CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

CHAPTER - I

INTRODUCTION AND REVIEW OF LITERATURE

It has long been recognized that the study of histology of epidermal appendages of leaf is an aid to the identification of species and to their classification. Angiosperms show diverse epidermal characters often correlated with taxonomic delimitation. Such epidermal characters have been recognised by Prat (1948) pertaining to three common categories viz., stomata, epidermal cells and trichomes. Trichomes or plant hairs are one of the most important components of plant epidermis and are of great significance to descriptive and experimental botanists. Cowan (1950) adopted the term 'Trichome' from Greek, meaning 'a hairy covering'. Trichomes are useful morphological and anatomical tools for systematic comparison of angiosperms, because of their almost universal occurrence, their variety and diversity and their easy preparation for study (Carlquist, 1961). Solereder (1908) in his 'Systematic Anatomy of Dicotyledons' writes, "The systematic value of the hairy covering is very great....."

Trichomes have attracted the attention of botanists from the early days. Linnaeus (1735) distinguished the trichomes as subsidiary organs along with stipules, bracts, spines, thorns and tendrils of the plants called "fulera". The first scientific definition of trichome was given by Jung in his "Isogoge Phytoscopia" (in Sachs, 1890, p. 61). According to him trichomes are the structures, borne by the upper parts of plants and are of secondary rank as compared to stem, leaf, flower and fruit. The term trichome is used in a very broad sense to designate collectively all diversified unicellular and multicellular appendages that develop from epidermal as well as from sub-epidermal cells. According to De Bary (1884) such structures are called emergences. The distinction between trichomes and emergences is an aspect which still needs much attention. Ramayya (1964) in the light of the ontogenetic and comparative morphological evidences of several angiosperms, concluded that trichomes are distinct from emergences. Recently, Levine (1973) has defined the term trichome as a hair-like appendage extending from the epidermis of an aerial tissue. Trichomes which are common on almost all the angiospermic plant parts in a multitude of forms and size, furnish a rich field for morphogenetic investigations. But the interest in trichomes has long been quite superficial in earlier days. Hanstein gave due consideration to trichome

characters for taxonomic delimitations as long back as 1868. He figured glandular hairs on the leaf buds of Azalea indica L. In recent past, Carlquist (1958, 1959a, 1959b) studied the structure and ontogeny of glandular trichomes of Madinasa, Calydenia and Holocarpa. A number of studies have proved the taxonomic value of trichomes, not only at generic level but also to evaluate the ideas on relationship among families. Cowan (1950) has emphasized that trichomes provide excellent criteria for distinguishing sub-generic and specific levels in Rhododendrons. Similarly, form and distribution of trichomes was correlated with specific and subgeneric distinctions in Nicotiana by Goodspeed (1954).

In recent years also the use of trichomes for taxonomic delimitations has been stressed by many workers in various groups (Sporne, 1956; Mathur, 1961; Inamdar, 1967; Ramayya & Rajgopal, 1971; Patel & Inamdar, 1972; Jain & Singh, 1973; Ramayya & Prabhakar, 1973; Martinus, 1974; Singh et al., 1974; Guedes, 1975; Knoboch et al., 1975; Oleson, 1975; Rollins & Banerjee, 1975; Singh & Jain, 1975; Ahmad, 1976; Rao & Ramayya, 1977; Fahn & Shimony, 1977; Lorsten, 1977; Akers et al., 1978; Tiwari, 1978; Turner et al., 1978; Chose, 1979; Franklin, 1979; Dave et al., 1979; Rajagopal, 1979; Hardin, 1979; Styer & Stern, 1979; Dahgan, 1980; Sahu, 1977, 1982, 1984, 1985; Mishra, 1984, 1985; Werker et al., 1985; Fahn, 1986 and Cornall, 1986).

Besides the vegetative parts, trichomes of floral parts have also been studied in Cleome viscosa of Capparidaceae (Ramayya & Gopalcharulu, 1968), Iponoea of Convolvulaceae (Inamdar, 1968), Capsicum of Solanaceae (Raghuvarshi & Singh, 1972), Utricularia of Lantabulariaceae (Hashmi & Siddiqui, 1974), Scrophulariaceae (Datta & Deb, 1975), Solanum species of Solanaceae (Siddiqui et al., 1978), Corchorus tridens of Tiliaceae (Gour, 1979), Crotolaria of Papilionaceae (Gupta, 1980), Canavalia gladiata of Papilionaceae (Shah & Mohandas, 1982) and Verbenaceae (Kaushal & Tripathi, 1984). For the first time Ramayya (1977) established the role of trichomes for gallie responses in some plants.

Recently, extensive work has been done on different aspects of trichomes. Trichomes play an important role in plant defence, especially in relation to phytophagous insects. In a number of plant species there is a negative correlation between trichome density and insect feeding, oviposition responses and nutrition of larvae (Levine, 1973). A relationship between pubescence and pest resistance was established by Poose (1929). Poose & Smith (1931), reported that the extent of injury is related to the amount and type of pubescence. Further, the glabrous varieties are the sufferers of greater infestation and oviposition than the pubescent

varieties. Johnson (1953) reported that larva or adult of Aphis graminivora may be permanently impaired or die by the presence of hooked trichomes on French bean (Phaseolus vulgaris). In some groups of plants, protection against large mammals is achieved by the presence of stinging trichomes (Levine, 1973). In this regard, detailed study of morphology and toxicology of stinging hairs has been carried on by many workers on various plants viz., Jatropha (De Condolle, 1832; Haberlandt, 1914), Tragia voluvis (Cruger, 1855; Stahl, 1888; Kohl, 1889 and Knoll, 1905), Urtica dioica and U. arena (Wicke, 1861; Rauter, 1872), Tragia cannabina (Rao & Sundraraaj, 1951) and Tragia saxicola & Urtica dioica (Thurston, 1969, 1974).

As trichomes are often characteristic to particular species their usefulness to analysis of hybrids was also considered by Canon (1909), Rollins (1944), Heiser (1949), and Goodspeed (1954). The demonstration of hybrid origin of Vernonia taxa by comparison of the trichome compliments of the two parental species and their hybrid progeny was given by Hunter & Austin (1967). Bernard & Singh (1969) studied the inheritance of pubescence in soybeans.

Recently, Sharma and Tyree (1973) have studied the role of trichomes in relation with environmental pollution. They have suggested that trichomes can be used as indicators of environmental pollution. Wegener (1975) found that the trichome density and length is changed in highly polluted area.

Under well preserved conditions, the trichomes provide an aid to the study of fossils. Trichomes along with stomata and cuticle have rendered much help in the identification and reconstruction of several fossil forms, such as Lagenaria oldhamia (Scott, 1923). Morphological characters of trichomes are often employed in the identification of diverse plant materials, such as foliar and cauline parts (Bower, 1926), flowers and fruits (Chitale, 1954).

Classification of the trichomes of angiosperms has been earlier attempted by several workers and a review of different classifications is given by Netolitzky (1932) in his Die Pflanzenhaare. He has suggested two main categories of classifications:

- (a) Structural classification, and
- (b) The ontogenetic classification.

Classification of trichomes based on their structure has been attempted by many workers. Among them Weiss (1867) was the first who divided plant hairs into three major groups; viz., (a) all the constituent cells of hairs are of same kind, (b) all the constituent cells are not of the same kind, (c) cells provided with a secretion (cf. Uphof, 1962, p. 11). Router in 1872 (cf. Uphof, 1962), proposed possibly the first ever classification of trichomes based on ontogeny. He divided them into two groups: (a) those derived from epidermal cells and (b) others which have their origin in epidermal as well as subepidermal cells (emergence). De Bary (1884) classified trichomes into the following six types: (a) Papillose, (b) Hairs, (c) scales, (d) Shaggy hairs, (e) Warts, and (f) Prickles. Solereder (1908) recognized two main categories of trichomes i.e., the cottony hairs or nonglandular, and glandular hairs. In recent years a good number of papers have been published which deal with trichomes and their systematic classification. Some noteworthy ones are those of Hummel and Staesche (1962), Ramayya (1962), Inamdar and Patel (1973), Singh & Jain (1975), Alleykutty and Inamdar (1978), and Leelavathi & Ramayya (1983).

Of the several classifications of mature trichomes available in the literature, the one presented by Ramayya

(1962a, 1962b), in connection with the trichomes of the Compositae, is the most natural. It stresses the basic structural patterns of trichomes and it is also very close to the ontogenetic classification presented by the same author (1972). He has divided vegetative trichomes of angiosperms in five phyletic systems (a) unicellular, (b) uniseriate filiform, (c) uniseriate macroform, (d) m-multiseriate, and (e) p-multiseriate. Hence, in order to consider the value of trichome in classification and phylogeny it is necessary that trichome types and trichome systems should be thoroughly studied. The ontogenetic evidence not only throws new light on the trichome phylogeny but also offers a consistent criterion for classification.

The utility of hairs as taxonomic characters is marred by the fact that no standard terminology exists for them due to many reasons. Some of them are as follows:

- (A) Single term cannot be applied for compound structure of hair, as the multitude of hair features requires numerous descriptive terms, just as do other plant parts, for example leaf is described under several criteria viz., colour, size, texture, shape, ray orientation, etc.
- (B) Often a continuous range of complexity of hairs from unicellular or uniseriate to multiseriate and/or multirayed complex types occur in a single species.

(C) Use of relatively few terms to describe even many recently studied hair types in a rather general and inconsistent manner.

(D) Lack of standard terminology for trichomes. Further, the delimitation of trichome types of angiosperms is problematic due to frequent intergradation of one type to the other and due to lack of knowledge about their exact number of types. The main reason behind it is that no standard nomenclature is so far in use and the data available in the relevant literature is scanty and very often confusing.

Metcalfe and Chalk (1950) classified trichomes into two main groups i.e., nonglandular and glandular. However, Cowan (1950) used precise terminology for the first time during the studies of trichomes in Rhododendron. Ramayya (1962) has given hi-to polynomial names to the trichomes. Recently, the need for use of precise terminology in describing the trichomes has been stressed and is given by Roe (1971). However, the names suggested by him are too lengthy (e.g., sessile porrect stellate hair with long central ray, short stalked porrect stellate hair with short central ray, etc.) to be communicative and inconvenient for comparison. Further, they are not indicative of the general structural pattern on which they are built. Payne (1978) was the first to publish a most concised terminology for hairs.

Trichomes have attracted the attention of botanists from the very early days; however, in those days the interest in plant hairs was quite superficial. In recent years scientists have increasingly realised that a great deal is still to be learnt about the importance of individual trichomes in the life cycle, about their influence on development of organ upon which they mature (often at very early stages) and about their role as waste repositories and as primary recipient of environmental stimuli and forces.

Considerable interest seems to have been created in studying the plant trichomes leading to accumulation of sufficient data in many orders and families of angiosperms. For example, Compositae (Ramayya, 1962), Oleaceae (Inamdar, 1967), Aizoaceae (Ramayya and Rajagopal, 1971), Gentianales (Patel and Inamdar, 1972), Polymoniales (Inamdar and Patel, 1973), Loganiaceae (Bendre, 1973), Gesneriaceae (Sahasrabudha and Stace, 1974), Cucurbitaceae (Inamdar and Gangadhar, 1975), Malvaceae (Ramayya and Rao, 1976), ^aCapp₄ridaceae (Gupta and Murthy, 1977; Alleykutti and Inamdar, 1978), Euphorbiaceae (Inamdar and Gangadhar, 1977), Acanthaceae (Ahmad, 1978), Combretaceae (Stace, 1980), Ran^aiales (Alleykutti, 1980), Helianthoidae (Sahu, 1982b), Vernoniaceae and Senecionoideae (Sahu, 1983a), Cossalpinioideae (Leelavathi and Ramayya, 1983) and Euphorbiaceae (Mishra, 1984).

Although trichomes vary in structure within larger and smaller groups of plants, they are remarkably uniform and may be used for taxonomic purposes (Cowan, 1950). In view of this, Uphof and Hummel (1962) have emphasized the need for detailed study of trichomes on different organs in various plant groups to establish homology.

Taxonomic and phylogenetic importance of trichome evidence is widely recognized. According to Sporne (1956), glandular character of leaves is very well correlated with many groups. King and Robinson (1970) have used trichome character along with other epidermal features for determining generic circumscriptions in Compositae. But in all such attempts, the qualitative characters of trichomes are taken into account. Consequently, the trichome evidence used is of little importance. In order to understand the value of trichome evidence in classification and phylogeny, it is necessary that trichome types and trichome systems are considered.

Besides the taxonomic utility, trichomes have been proved to be of immense value in pharmacognostic studies. Along with other characters, they have been extensively used in identification of drugs (Small, 1919; Youngken, 1954).

Scrophulariaceae is a large family comprising of 220 genera and 3,000 species (Willis, 1966) and cosmopolitan in distribution. It is represented very well in temperate regions of both the hemispheres, and gradually diminishes towards the tropical regions as well as the extremely colder parts of the earth (including polar regions). Among the Indian flora, they are common in the plains and occur in large numbers on the mountains. The tribes of the family which prevail in the hills comprise those genera which are chiefly found in the temperate countries, though of these a few species occur also in the plains, but only during the cold weather. The tropical genera which occur on the mountains, spring up entirely in the rainy season. The tribes which are represented in the mountains are Verbasceae, Antirrhineae, Veroniceae and Rhinanthese. Scrophularia, Pedicularis and Veronica are represented by several species while Verbascum and Euphrasia by one species each. The European species which are found on the Himalayas are Verbascum thapsus, Euphrasia officinalis, Veronica alpina, V. biloba, V. beccabunga, V. serpyllifolia and V. anagalis, Pedicularis verticillata and P. versicolor. Most of the Scrophs, which prevail in the plains of India and especially in warm and rainy seasons belong to the tribes Gratiolaeae, Buddleae and Gerardieae with Celsia of Verbasceae.

However, some genera of other tribes viz. Lindenbergia, Stemodia, Mazus, Mimulus, Bonnaya, Torenia, Buchnera, Gerardia, Centranthera and Buddlea are also found on the mountains in the rainy season.

The members of this family are mostly herbs or under-shrubs, rarely shrubs. The family is having a number of genera which are economically useful as medicinal plants such as Antirrhinum, Mimulus, Pinaria, Russelia, Kickxia, Torenia, Digitalis, Scoparia and Veronica. Digitalis leaves yield a heart stimulant called digitalin. Powdered dry plant of Antirrhinum majus is given to stop bleeding from nose. Kickxia ramosissima is useful for diabetes. Veronica is useful in purifying blood and is also used in skin diseases.

Bentham and Hooker (1873) in their "Genera Plantarum" classified the family Scrophulariaceae into three series i.e., Pseudosolanaceae, Antirrhinideae and Rhinanthideae. Wettstein's classification (1897) retained the same major groups as sub-families i.e., Pseudosolanoideae, Antirrhinoideae and Rhinanthoideae. But Pennell (1935) dropped the group Pseudosolanaceae. Hooker (1885) in his 'Flora of British India' recognized 9 tribes representing three series. He further classified some of the tribes into sub-tribes viz., Gratioloae (5 sub-tribes), Digitalae (3 sub-tribes) and

Gerardiaceae (3 sub-tribes). The outstanding differences among these exhaustive treatments are in the positions and delimitations of tribes under the sub-families or series. Major groups in the classifications given below provide a vivid idea about the basic differences.

(a) Bentham and Hooker (1873)

Series I Pseudocolanaceae

Tribe Leucophylleae

" Aptosiaceae

" Verbasceae

Series II Antirrhinideae

Tribe Calceolarieae

" Hemimerideae

" Antirrhineae

" Cheloneae

" Manuleae

" Gratiolae

Series III Rhinanthideae

Tribe Digitalae

" Gerardiaceae

" Euphrasieae

(b) Wettstein (1897)

Sub-family : I Pseudosolanoidae

Tribe Verbasceae

" Aptosimeae

Sub-family : II Antirrhinoideae

Tribe Hamamerideae

" Calceolareae

" Antirrhineae

" Cheloneae

" Manuleae

" Gratioleae

" Selagineae

Sub-family : III Rhinanthoideae

Tribe Digitaleae

" Gerardiaceae

" Rhinanthaceae

(c) Pennel (1935)

Sub-family : I Antirrhinoideae

Tribe Gratioleae

" Verbasceae

" Leucophylleae

" Collinsiaeae

" Antirrhineae

Sub-family : II Rhinanthoideae

Tribe	Digitaleae
"	Veroniceae
"	Buchneraceae
"	Euphrasieae

Much has been written about Scrophulariaceae pertaining to its various aspects like foliar anatomy (Stephens, 1912; Kraemer, 1912; Holm, 1929, 1942; Dewar, 1933, 1934; Dewar & Walis, 1935; Rowson, 1946 and Keisten & Juergen, 1985); floral anatomy (Saunders, 1934; Srinivasan, 1940; Kristen & Iyenger, 1937, 1940a & b; Raghavan & Srinivasan, 1941; Safeculia & Govinda Rao, 1950; Srinivasan, 1946; Datta & Deb, 1975; Armstrong, 1985 and Bolliger, 1985); wood anatomy (Solereeder, 1908; Deb & Datta, 1977 and Michener, 1983, 1986); Cytology (Srinivasan, 1946; Kallarakal & Bhatnagar, 1980; Canne, 1983b; Freeman, 1983; Bigoszi, 1984; Greenlee et al., 1984; Hong, 1984; El Baba, 1985; Vitek, 1985, 1986; Koniuszek et al., 1986 and Mirek & Fischer, 1986), embryology (Stephens, 1910; Holm, 1924, 1926; Krishna Iyenger, 1937; 1940a, 1940b; Srinivasan, 1940; Raghavan & Srinivasan, 1941; Safeculia & Govinda, 1950; Tiagi, 1956, 1965, 1966; Arkal, 1963; Schrock & Palser, 1967; Vijayaraghavan & Ratnaparkhi, 1972; Kumar & Tiagi, 1981; Natesh & Bhandari, 1984; Bhandari & Natesh, 1985; Shah, 1985;

Elisens, 1986 and Speta, 1986), morphology and taxonomy (Watson & James, 1941; Canne, 1983a; Snogerup, 1983; Sivarajan & Philip Mathew, 1983; Karlsson, 1984; Molau, 1984; Marticomnea & Kalin, 1984; Lee & Stuckey, 1985; Shultz & Shultz, 1985; Wannan & Waterhouse, 1985 and Al-Musa'wi & Al-Bermani, 1986).

Work done so far on the trichomes of this family is not extensive as compared to its large size. Information available on the trichomes of Scrophulariaceae is also meagre. Except the work of Metcalfe and Chalk (1950) and Datta & Deb (1975), who studied a few taxa of Scrophulariaceae no exhaustive work has been done on the trichome aspect of the family.

In view of the above facts, the present investigations were undertaken which deal with detailed study of structure, organographic distribution and taxonomic significance of vegetative as well as floral trichomes of 98 species belonging to 39 genera, representing three series (sub-families), Pseudosolanaceae, Antirrhinideae and Rhinanthideae of the family Scrophulariaceae.

CHAPTER II

MATERIALS AND METHODS

CHAPTER - II

MATERIAL AND METHODS

Present study is based on 98 species belonging to 39 genera representing 3 series viz. Pseudosoloneae, Antirrhinideae and Rhinanthideae of Scrophulariaceae (Tables I to III).

The species were collected from different parts of the country particularly from the hills of Kashmir, Dehra Dun, Mussoorie, plains of North India and a few were locally collected (from Bhopal). In addition to the field collection, herbarium specimens of some taxa were also procured from Systematic Botany Branch, F.R.I., Dehra Dun, N.B.R.I. Lucknow and Herbarium of Botany Department of Universities of Kashmir and Jodhpur (Rajasthan).

The taxa collected were compared with specimens kept in the Herbaria of N.B.R.I., Lucknow and F.R.I., Dehra Dun and identified.

Trichomes were studied in the epidermal peels for their structure, type and distribution on different parts (viz., stem, petiole, leaves, pedicel, inflorescence axis, bracts/bracteoles, calyx, corolla, stamens and carpels). Epidermal peels of fresh as well as herbarium materials, were taken out for trichome study following the method of Leelavathi and Ramayya (1975). Both vegetative and floral parts of each species were initially boiled in 5-10% of HCl (hydrochloric acid) or HNO_3 (Nitric acid). After washing with water the materials were then boiled in 5% NaOH (sodium hydroxide). The materials after cooling were again washed thoroughly in water to get them free from alkali. The peelings were then stained with aqueous safranin and mounted in glycerine. For storing, slides were made semipermanent by ringing the edges of cover slips with the mountant (D.P.X.)

The slides were studied for trichome structure under the microscope and camera lucida diagrams of the trichomes were drawn. Photomicrographs of some important trichome types were also taken.

The terminology used in the present study is based on that of Solereder (1908), Ramayya (1962) and Payne (1978).

Various terms used in the description of trichome parts are briefly explained hereunder:

(a) Foot

It is proximal part of the trichome lying within the epidermal surface. It is recognized into two kinds, vis.

- i) Simple: consisting of as many cells as the number of cell rows in the immediate overlying part.
- ii) Compound: consisting of cells which are more in number than the cell rows in the immediate overlying part.

(b) Body

It is the part of trichome lying above the foot i.e., away from the epidermal surface. It is of two categories, vis.

- i) Differentiated: consisting of two different parts
 1. Stalk - representing proximal region.
 2. Head - representing distal region.
- ii) Undifferentiated: The body of the trichome is entire, not differentiated into stalk and head.

Key based on characters of trichomes for identification of the taxa is also prepared separately for each series. These keys are given in Appendix 1, 2 and 3.

TABLE - I : NAMES OF TAXA OF THE SERIES PSEUDOSOLANEAEE
STUDIED FOR THEIR TRICHOMES

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>Anticharis glandulosa</u> Aschers	1
<u>A. linearis</u> Hochest	2
<u>Verbascum thapsus</u> Linn.	3
<u>V. erianthum</u> Benth.	4
<u>V. adenosplum</u> Schrenk, Enum	5
<u>V. spongaceum</u> Pennel	6
<u>Celaia coromandeliana</u> Vahl. Symb.	7
(Syn. <u>Verbascum chinensis</u> (L) Santapau)	

TABLE - II : NAMES OF TAXA OF THE SERIES ANTIRRHINIDEAE
STUDIED FOR THEIR TRICHOMES

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>Linaria ramosissima</u> Wall	1
(Syn. <u>Kickxia ramosissima</u> (Wall), Janchen.)	
<u>L. vulgaris</u> Mill.	2
<u>Kickxia subsessilis</u> Pennel.	3
<u>Antirrhinum orontium</u> Linn.	4
<u>A. majus</u> Linn.	5
<u>Scrophularia calycina</u> Benth.	6
<u>S. urticaefolia</u> Wall ex. Benth.	7
<u>S. polyantha</u> Royle ex. Benth.	8

Table-II contd.

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>S. decomposita</u> var. <u>typica</u> Royle ex. Benth.	9
<u>S. decomposita</u> esp. <u>latifolia</u> (Benth.) Pennel.	10
<u>Sutera glandulosa</u> Roth.	11
<u>Mimulus nepalensis</u> Benth.	12
<u>M. gracilis</u> Br. Prodr.	13
(Syn. <u>M. strictus</u> Benth.)	
<u>M. luteus</u> Linn.	14
<u>Mazus japonicus</u> (Thunb) O. Ktze	15
(Syn. <u>M. rugosus</u> Lour.)	
<u>M. surculosus</u> Don. Prodr.	16
<u>M. dentatus</u> Wall. ex. Benth.	17
<u>M. pumilus</u> (Burm. f.) Steenis	18
<u>Lindenbergia grandiflora</u> (Buch Ham. ex D. Don) Benth.	19
<u>L. macrostachya</u> Benth.	20
<u>L. indica</u> (Linn.) O. Ktze.	21
(Syn. <u>L. urticifolia</u> Lehm.)	
<u>L. muraria</u> (Roxb ex. D. Don) Bruch.	22
<u>Adenosma capitatum</u> (Benth.) Hance	23
(Syn. <u>A. indianum</u> (Lour.), Merr.)	
<u>Stenodia viscosa</u> Roxb.	24
<u>S. sufruiticosa</u> H.B. & K.	25

Table-II contd.

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>Linnophila sessiliflora</u> Blume Bijd.	26
<u>L. gratioloides</u> Br. prodr.	27
<u>L. chinensis</u> (Osbeck) Merrill.	28
<u>L. indica</u> (Linn.) Druce	29
<u>Bacopa monnieri</u> (Linn.) Pennel.	30
<u>B. procumbens</u> (Mill.) Greenm.	31
<u>Gratiola officinalis</u> Linn.	32
<u>Dopatrium junceum</u> Linn.	33
<u>Artanema angustifolium</u> Benth.	34
<u>Craterostigma plantigena</u> Hochest.	35
<u>C. pumilum</u> Hochest.	36
<u>Torenia cordifolia</u> sensu, Hook. (Syn. <u>T. indica</u> saldenha.)	37
<u>T. fournieri</u> Linden ex. Fourn.	38
<u>T. violacea</u> (Asaolo ex. Blanco), Pennel.	39
<u>Vandellia mollis</u> Benth.	40
<u>Lindernia crustacea</u> (Linn.) F. Muell. (Syn. <u>Vandellia crustacea</u> (Linn. Benth.)	41
<u>L. ciliata</u> (Colem.), Pennel.	42
(Syn. <u>Bonnaya brachiata</u> . Link & Otto)	
<u>L. parviflora</u>	43

Table-II contd.

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>Angelonia grandiflora</u> C. Morr.	44
<u>A. gardeneri</u> Hook.	45
<u>Calceolaria mexicana</u> Benth.	46
<u>C. gracilis</u> H.B. & K.	47
<u>Russelia equisetiformis</u> Schlech & Cham.	48
<u>R. coccinea</u> Wettst.	49
<u>R. floribunda</u> Woodrow	50
<u>Collinsia bicolor</u> Benth.	51
<u>Nemesia strumosa</u> Benth.	52

TABLE - III : NAMES OF TAXA OF THE SERIES RHINANTHIDEAE
STUDIED FOR THEIR TRICHOMES

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>Hemiphragma heterophyllum</u> Wall.	1
<u>Scoparia dulcis</u> Linn.	2
<u>Wulfenia amherstiana</u> Benth.	3
<u>Veronica anagalis - aquatica</u> Linn.	4
<u>V. beccabunga</u> Linn.	5
<u>V. agrestis</u> Linn.	6
<u>V. persica</u> Poir	7
<u>V. biloba</u> Linn.	8

Table-III contd.

<u>Taxa</u>	<u>Numbers allotted to each taxon</u>
<u>V. verna</u> Linn.	9
<u>V. arvensis</u> Linn.	10
<u>V. serpyllifolia</u> Linn.	11
<u>V. undulata</u> Wall.	12
<u>V. eriocarpa</u> Pennel.	13
<u>V. melissaefolia</u> Poir.	14
<u>Digitalis purpurea</u> Linn.	15
<u>D. lanata</u> Ehrh.	16
<u>Alectra indica</u> Benth.	17
<u>A. parasitica</u> var. <u>Chitrakutensis</u> Rau	18
<u>A. sessiliflora</u> Kuntze.	19
<u>Buchnera hispida</u> Ham. ex. Don. Prodr.	20
<u>Striga orobanchoides</u> Benth.	21
(Syn. <u>S. gesneroides</u> (Willd.) Vatke)	
<u>S. lutea</u> Lour.	22
(Syn. <u>S. asiatica</u> (Linn.) Kuntze)	
<u>S. euphrasioides</u> Benth.	23
(Syn. <u>S. angustifolia</u> (D. Don) Saldanha)	
<u>Centranthera nepalensis</u> D. Don Prodr.	24
(Syn. <u>C. hispida</u> sensu Hook. f.)	
<u>Sorubia delphinifolia</u> (Linn.) D. Don.	25

Table-III contd.

<u>Taxon</u>	<u>Numbers allotted to each taxon</u>
<u>S. trifida</u> Bunch. Ham. ex. D. Don. Prodr.	26
<u>Euphrasia officinalis</u> Auct. non Linn. Hook f.	27
(Syn. <u>E. simplex</u> D. Don. Prodr.)	
<u>E. laxa</u> Pennel.	28
<u>E. jaeschkei</u> Wettst.	29
<u>Pedicularis pectinata</u> ssp. ⁿ <u>bipinatifida</u> Pennel	30
<u>P. pectinata</u> var. <u>typica</u> Wall.	31
<u>P. brevifolia</u> D. Don.	32
<u>P. flexuosa</u> Hook. f.	33
<u>P. verticillata</u> Roxb.	34
<u>P. bifida</u> (Buch-Ham) ex. D. Don Pennel.	35
(Syn. <u>P. carnea</u> Wall)	
<u>P. asplenifolia</u> Hook. f.	36
<u>P. pyramidata</u> Royle.	37
<u>P. plantilingii</u> Prain.	38
<u>P. oederi</u> Vahl.	39

CHAPTER III

STRUCTURE OF TRICHOME TYPES

- a) Series - Pseudosolanaceae
- b) Series - Antirrhinideae
- c) Series - Rhinanthideae

CHAPTER - III

STRUCTURE OF TRICHOME TYPES(a) SERIES - PSEUDOSOLANAEAE

Seven species belonging to three genera of the series Pseudosolanaceae have been studied for their trichomes. Structural details of the trichomes and their distribution on various parts of the individual species are given below.

Anticharis glandulosa

This species shows seven types of trichomes (Plate 1, Figs. 1-8).

1. Unicellular flagellate

Foot: Simple. Body: Entire, flagellate, tip pointed; lateral wall thick and smooth; lumen narrow; content translucent. (Fig. 1).

Distrib. : Leaf and Calyx - lower surface.

2. Unicellular conical

Foot : Simple. Body : Entire, erect, tip pointed; lateral wall thick and smooth; lumen narrow; content translucent. (Fig. 2).

Distrib. : Stem, Bract, Pedicel and Calyx.

3. Unicellular cylindrical

Foot : Simple. Body : Entire, straight, tip rounded, prominent striation on the whole body; lateral wall thin and smooth; lumen wide; content translucent. (Fig. 3).

Distrib. : Stem, Leaf - upper surface, Pedicel and Anther.

4. Bicellular conical

Foot : Simple. Body : Entire, erect and striated, upper cell longer than lower one, enavescent, tip pointed; lateral wall thin or thick and constricted at joint; lumen wide or narrow; content translucent (Figs. 4 & 5).

Distrib. : Stem, Bract, Pedicel and Anther.

5. Uniseriate conical

Foot : Simple. Body : 3-4 celled, entire, striated, falciform, tip pointed; lateral wall thin or thick, rugose and constricted at joints; lumen narrow; content translucent (Fig. 6).

Distrib. : Pedicel and Anther.

6. Unicellular glandular capitate

Foot : Simple. Body : Differentiated, curved; stalk 1-celled, short, narrow; head multicellular, enlarged, rounded with invagination at center, cells elongated, thin, radiating from centre, cell walls thin and smooth; content opaque (Fig. 7).

Distrib. : At the base and middle part of style.

7. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated, stalk 3-6 celled long, basal cell longer than those of the upper, terminal cell short, collar-like; lateral wall thin and smooth; cross walls thin; lumen wide; content translucent; head expanded, saucer- or cup-like, multicellular, cells elongated, glandular, radiating from center, arranged in one tier, outer wall thick; content dense and granulated (Fig. 8).

Distrib. : Stem, Leaf, Bract, Calyx, Corolla and Ovary.

Anticharis linearis

This species shows five types of trichomes (Plate 1, Figs. 9-13).

1. Unicellular papillose

Foot : Simple. Body : Entire, straight, erect, tip rounded; lateral wall thin and smooth; lumen wide; content translucent (Fig. 9).

EXPLANATION OF THE FIGURES OF PLATE - 1

Trichomes from various plant parts

Figs. 1-8 : Anticharis glandulosa

Fig. 1 : Leaf

Fig. 2 : Stem

Fig. 3 : Stem

Fig. 4 : Flower pedicel

Fig. 5 : Bract

Fig. 6 : Flower pedicel

Fig. 7 : Base of style

Fig. 8 : Stem

Figs. 9-13 : Anticharis linearis

Fig. 9 : Leaf upper surface

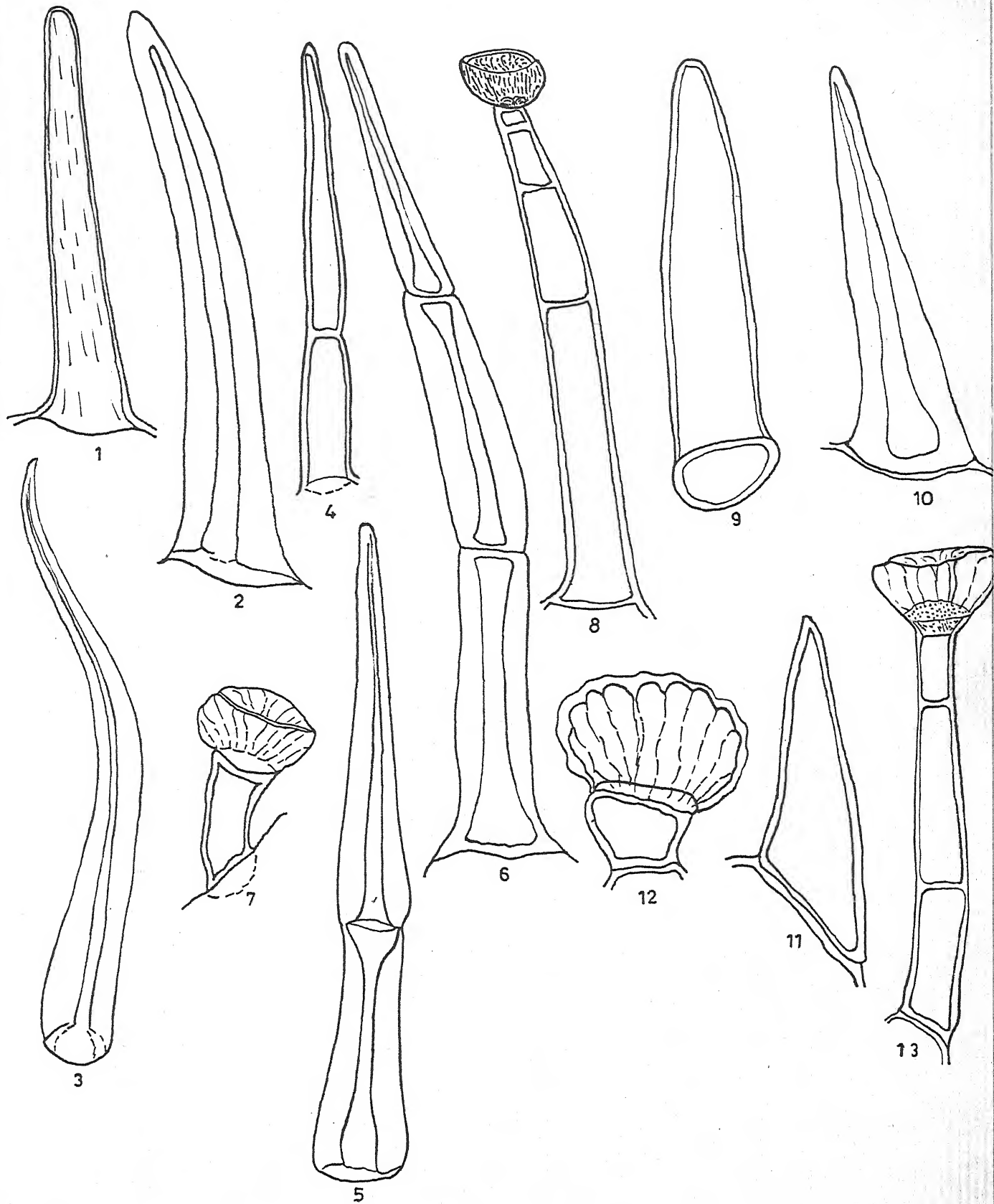
Fig. 10 : Calyx upper "

Fig. 11 : Leaf upper "

Fig. 12 : Stem

Fig. 13 : Stem

PLATE-1



1, 2, 9, 10	_____	} ALL 50μ
3, 4, 5, 6, 11	_____	
7, 12	_____	
8	_____	
13	_____	

Distrib. : Stem and Leaf.

2. Unicellular conical

Foot : Simple. Body : Entire, slightly arrect, tip pointed; wall thick and smooth; lumen narrow, content translucent (Fig. 10).

Distrib. : Pedicel and Calyx.

3. Unicellular dentate

Foot : Simple. Body : Entire, base broader, tip pointed; lateral wall thick and rugose; lumen wide; content translucent; (Fig. 11).

Distrib. : Leaf - margin and lower surface.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated, short, oval; stalk 1-celled, cell rectangular; head large and expanded, multicellular, cells elongated, arranged in vertical tiers, outer wall thin, smooth, and wavy; content translucent (Fig. 12).

Distrib. : Stem.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated, straight or curved; stalk 3-4 celled long, cells longer than broad; lumen wide;

head peltate or cup-shaped, multicellular, cells elongated, radiating from center, wall thin and smooth; content of head dark and granulated, and translucent of stalk (Fig. 13).

Distrib. : Stem, Leaf - lower surface, and Calyx.

Verbascum thapsus

This species shows seven types of trichomes (Plate 2 & 3, Figs. 14-20).

1. Unicellular papillose

Foot : Simple. Body : Entire, hyaline, fusiform, of varying length and breadth, tip rounded; lateral wall thin and smooth; lumen wide; content light yellowish and granulated (Fig. 14).

Distrib. : Anther filaments.

2. Unicellular clavate

Foot : Not visible; Body : Entire, long, flexuous, proximal end club-shaped, lateral wall thin and smooth; lumen narrow; content light yellowish (Fig. 15).

3. Sessile stellate multiradiate

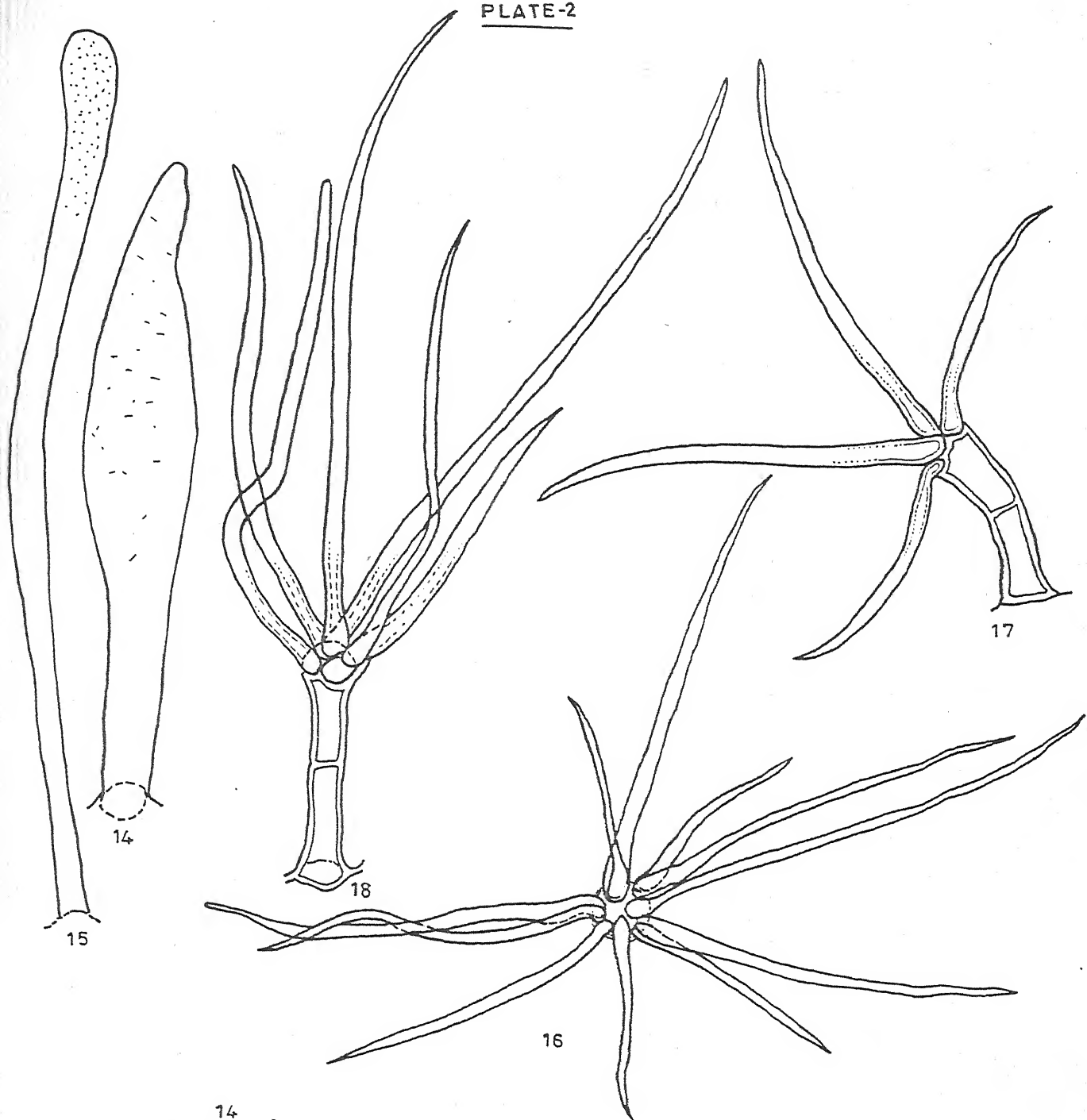
Foot : Not visible. Body : 6 - many radiate, parallel to epidermis; rays unicellular, long, aciform, tip pointed;

EXPLANATION OF THE FIGURES OF PLATE - 2

Trichomes from various plant parts

- Figs. 14-18 : Verbascum thapsus
Fig. 14 : Anther filament
Fig. 15 : Anther filament
Fig. 16 : Leaf
Fig. 17 : Stem
Fig. 18 : Stem

PLATE-2



14
15, 17, 18
16

ALL 50 μ

lateral walls thin and smooth; lumen narrow except base, content opaque (Fig. 16).

Distrib. : Upper surface of Leaf & Bract, Calyx, Corolla and Ovary.

4. stalked stellate tetraradiate

Foot : Simple. Body : Differentiated; stalk short, 2-celled, cells longer than broad, lumen wide; head 4-radiate, rays unicellular, long, fusiform or acicular, tip pointed, lumen narrow, lateral walls thin and smooth, cross walls thin; content translucent (Fig. 17).

Distrib. : Stem, Leaf, Calyx and Corolla - upper surface.

5. Stalked stellate multiradiate

Foot : Simple. Body : Differentiated; stalk 2-celled, cells longer than broad; head 5 - many radiate; rays unicellular, very long, acicular, tip pointed; lateral walls thin and smooth; lumen narrow; content translucent (Fig. 18).

Distrib. : Stem, Leaf, Calyx - upper surface, Style base and Ovary.

6. Dendroid

Foot : Simple. Body : Differentiated having a long, uniseriate axis and dividing to produce diverging rays; axis cells geniculate and produce many unicellular rays at

EXPLANATION OF THE FIGURES OF PLATE - 3

Trichomes from various plant parts

Figs. 19-20 : Verbascum thapsus

Fig. 19 : Stem

Fig. 20 : Calyx lower surface

Figs. 21-25 : Verbascum orianthum

Fig. 21 : Anther filament

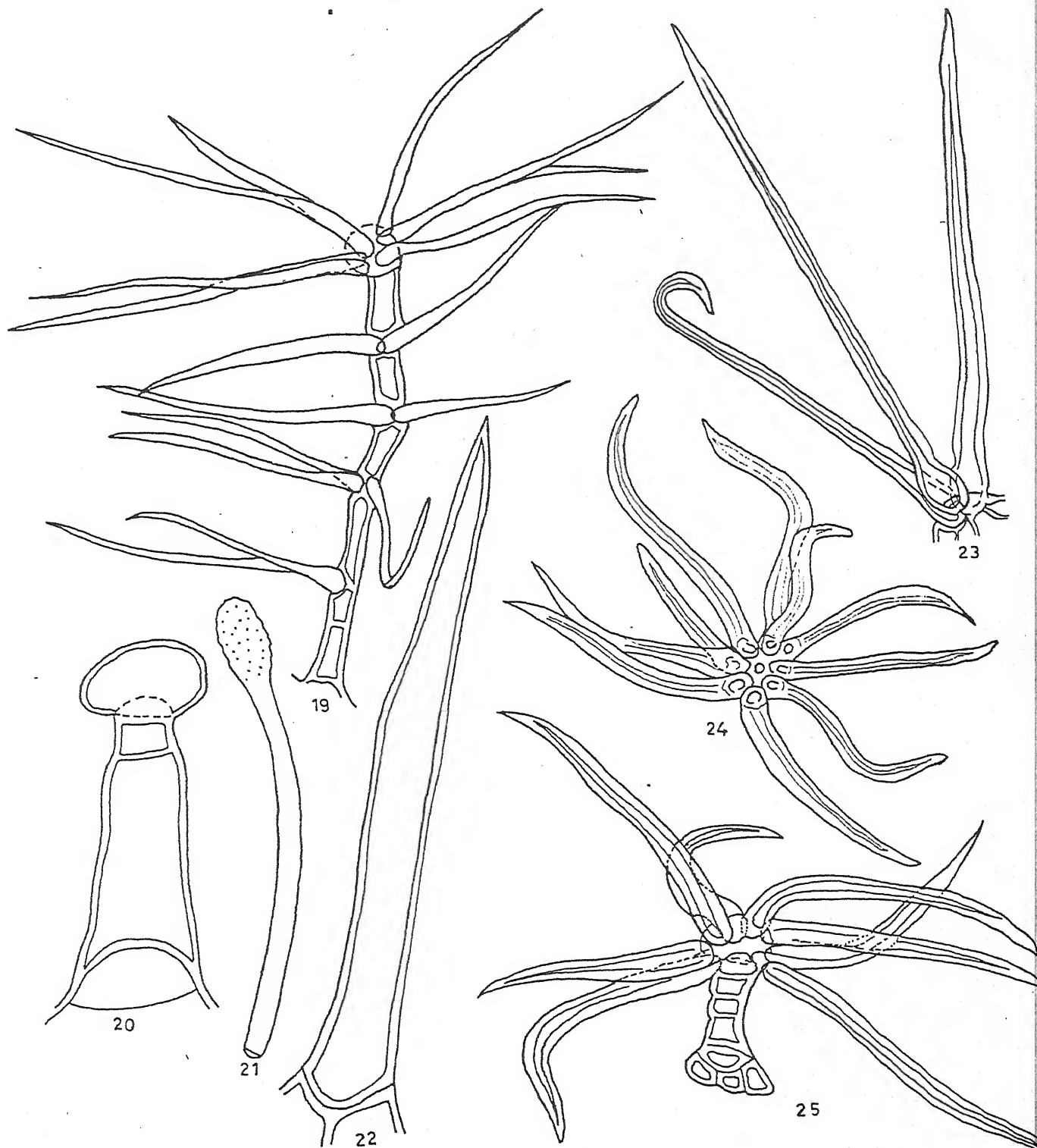
Fig. 22 : Ovary

Fig. 23 : Ovary

Fig. 24 : Corolla upper surface

Fig. 25 : Stem

PLATE-3



19,23 ———
 20,22 ———
 21 ———
 24,25 ———

ALL 50 μ

their upper end; rays very long, fleshy, approximate, tip pointed; lumen narrow; content opaque (Fig. 19).

Distrib. : Stem, Bract, Calyx, Leaf - upper surface and Corolla.

7. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, basal cell longer, upper short, appearing as collar of the head; head oval unicellular, outer wall thin and smooth; lateral wall thick and smooth; lumen wide; content translucent (Fig. 20).

Distrib. : Calyx - lower surface.

Verbascum orianthum

This species shows seven types of trichomes (Plates 3, & 4, Figs. 21-27).

1. Unicellular clavate

Foot : Not visible. Body : Entire, tubular, distal end clavate; lateral wall thin and smooth, except tip; lumen narrow; content yellowish and granulated (Fig. 21).

Distrib. : Anther filaments.

2. Unicellular conical

Foot : Compound. Body : Entire, erect, tip pointed; lateral

wall thick and smooth; lumen wide; content translucent (Fig. 22).

Distrib. : Ovary.

3. Sessile stellate triradiate

Foot : Not visible. Body : 3-radiate, erect, rays unicellular, filiform, tufted, tips pointed; lateral walls thick and smooth; lumen narrow, content opaque (Fig. 23).

Distrib. : Ovary.

4. Sessile stellate multiradiate

Foot : Not visible, except marking. Body : 6-10 radiate, rays unicellular, short, filiform, parallel to epidermis, tips pointed; lateral walls thick and smooth; lumen narrow; content opaque (Fig. 24).

Distrib. : Corolla.

5. Stalked stellate multiradiate

Foot : Compound. Body : Differentiated, stalk 3-6 celled, uniseriate, cells rectangular and of various sizes; head 6-9 celled, directly on the large terminal cell of the stalk; rays unicellular, long, filiform, tips pointed; lateral walls thick and smooth; cross walls thin; lumen narrow; content translucent (Fig. 25).

Distrib. : Stem, Leaf, Calyx, and Corolla.

6. Dendroid

Foot : Compound. Body : Differentiated into multicellular long geniculated axis and many lateral rays at each node; rays unicellular, tufted, acicular, tip pointed; lateral walls thin and smooth; cross walls of axis thick; lumen narrow; content translucent or opaque (Fig. 26).

Distrib. : Stem and Calyx.

7. Peltate porous glandular

Foot : Sunken, not visible. Body : Differentiated, having unicellular very short stalk and shield-like circular body; body parallel to epidermis, 2-celled in thickness, multicellular in diameter; cells narrow, elongated radiating from hollow center; outer wall thick, radial wall thin; content opaque (Fig. 27).

Distrib. : Stem.

Verbascum adenoseplum

This species shows 4 types of trichomes (Plate 4, Figs. 28-31).

1. Unicellular acuminate

Foot : Compound. Body : Entire, erect, tip pointed, lateral wall thin and smooth; lumen wide; content translucent (Fig. 28).

Distrib. : Stem, Leaf, Bract, Calyx, Corolla, Style and Ovary.

EXPLANATION OF THE FIGURES OF PLATE - 4

Trichomes from various plant parts

Figs. 26-27 : Verbascum erianthum

Fig. 26 : Calyx upper surface

Fig. 27 : Stem

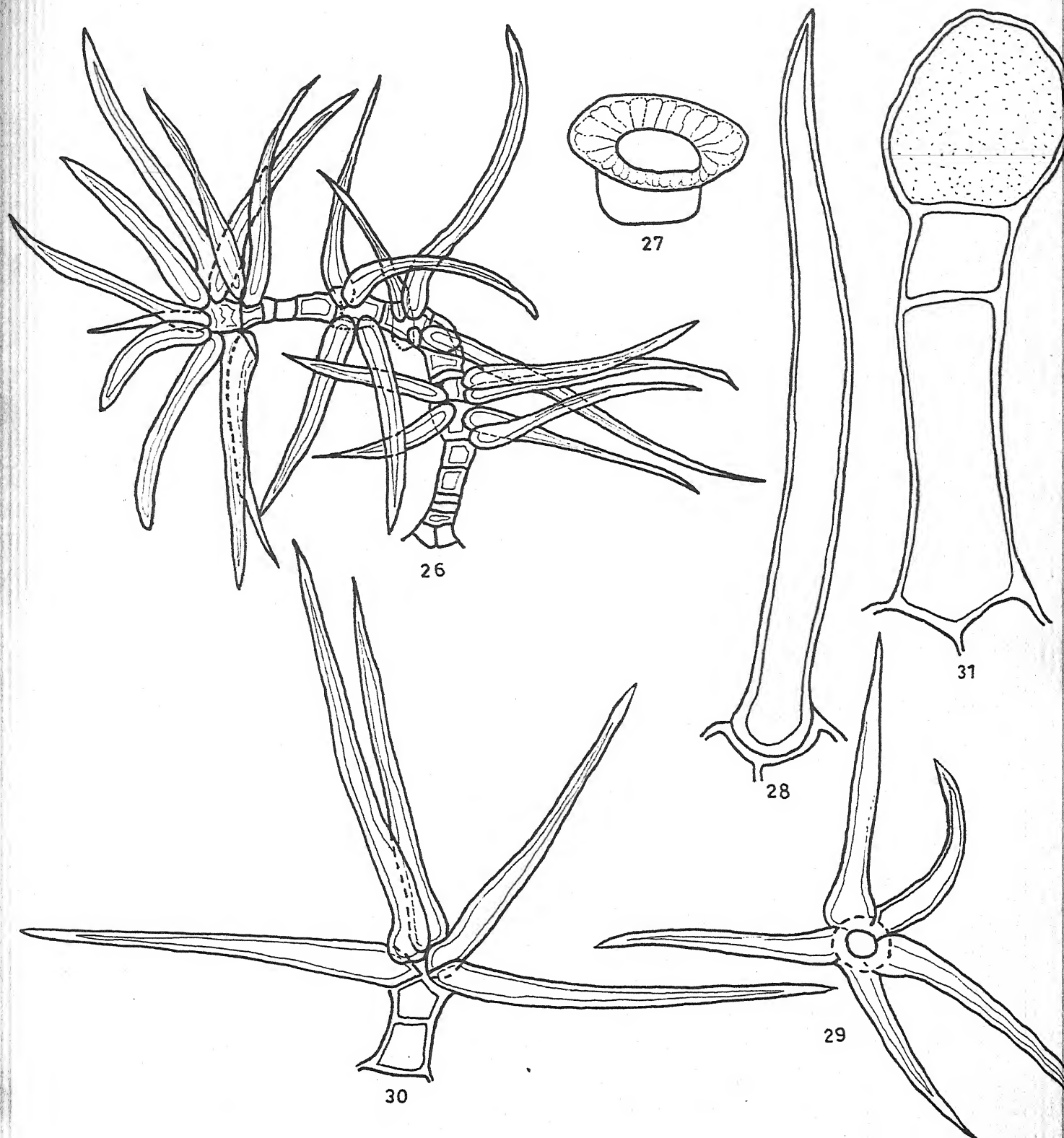
Figs. 28-31 : Verbascum adenoseplum

Fig. 28 : Ovary

Fig. 29 : Stem

Figs. 30, 31 : Leaf upper surface

PLATE-4



26	_____	} ALL 50/μ
27	_____	
28,29,30	_____	
31	_____	

2. Sessile stellate multiradiate

Foot : Not visible. Body : 5-radiate, parallel to epidermis; rays unicellular, elongated, acuminate, tips pointed, lateral walls thin and smooth, lumen narrow, content opaque (Fig. 29).

Distrib. : Stem, Leaf, Bract, Calyx, Corolla, and Ovary.

3. Stalked stellate multiradiate

Foot : Simple. Body : Differentiated, stalk 2-celled, short, cells rectangular; head 5-radiate; rays unicellular, long, straight, aciculate, tips pointed, lateral wall thin and smooth; lumen narrow; content translucent (Fig. 30).

Distrib. : Leaf, Bract, Calyx, Corolla, and Ovary.

4. Bicellular glandular capitate

Foot : Compound. Body : Differentiated; stalk 2-celled, basal cell much longer than the upper, lumen wide; head 1-celled, large, globular, outer wall thin and smooth; lateral wall thick and smooth; content of stalk translucent and of head dark and granulated (Fig. 31).

Distrib. : Leaf.

Verbascum soongraceum

This species shows nine types of trichomes (Plate 5, Figs. 32-40).

1. Unicellular clavate

Foot : Simple. Body : Entire, very long, flagellate, tip swollen, club-shaped; lateral wall thin and smooth; lumen wide; content light granulated (Fig. 32).

Distrib. : Anther filaments.

2. Unicellular filiform

Foot : Compound. Body : Entire, erect, filiform, tip rounded; lateral wall thin and smooth; lumen narrow; content translucent (Fig. 33).

Distrib. : Stem, Leaf, Calyx and Corolla.

3. Sessile stellate multiradiate

Foot : Not visible. Body : 6-10 radiate; rays unicellular, filiform or conical, parallel to epidermis, tips pointed; lateral walls thick and smooth; lumen narrow; content opaque (Fig. 34).

Distrib. : Stem, Leaf, Calyx, and Corolla.

4. Stalked stellate biradiate

Foot : Simple. Body : Differentiated; stalk long, multicellular, 3-5 celled, cells much longer than broad or rectangular; head 2-radiate (2-armed); rays unicellular, acicular, or long flexuous, filiform, tip pointed, lumen narrow; lateral walls thick and smooth; lateral walls of

stalk thin and smooth; cross walls thin; content translucent (Fig. 35).

Distrib. : Style.

5. stalked stellate triradiate

Foot : Simple. Body : Differentiated; stalk, short 2-celled; head 3-radiate; rays unicellular, short, conical, lateral walls thick and smooth; lumen narrow; content opaque (Fig. 36).

Distrib. : Style - base.

6. stalked stellate multiradiate

Foot : Simple. Body : Differentiated; stalk short, 2-celled, cells rectangular; head 4-7 radiate; rays unicellular, long, acicular or conical, tips pointed; lateral walls thick and smooth; lumen narrow; content opaque (Fig. 37).

Distrib. : Leaf, Pedicel, Calyx, Corolla and Style - base.

7. Peltate porous glandular

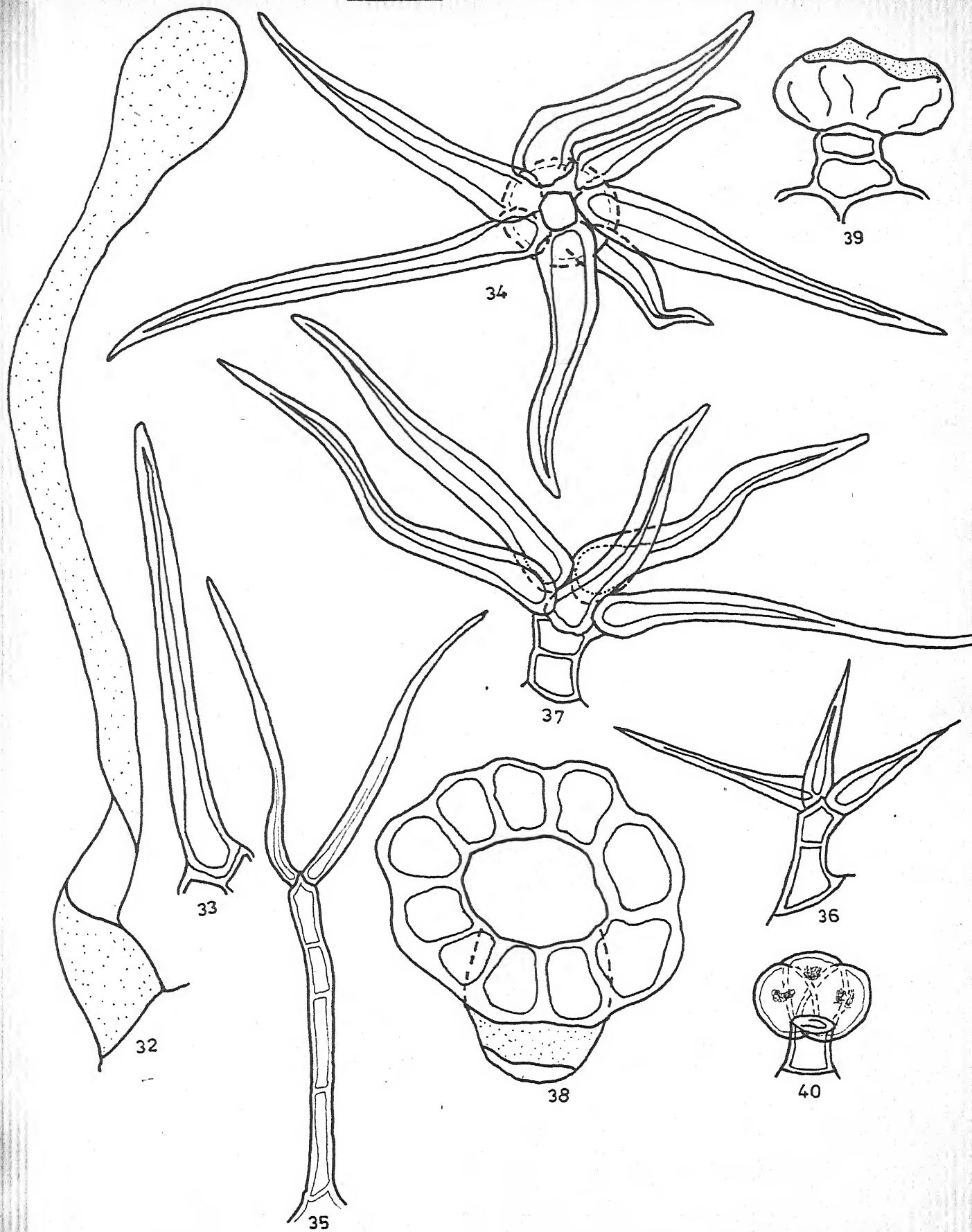
Foot : Simple. Body : Differentiated; stalk, hyaline, short, wide and 1-celled; head multicellular, 1-celled, thick, peltate disc, cells rectangular, arranged around periphery of porous center; outer walls thick, smooth and convex, content translucent and granulated (Fig. 38).

Distrib. : Stem and Calyx.

EXPLANATION OF THE FIGURES OF PLATE - 5

Trichomes from various plant parts

- Figs. 32-40 : Verbascum soongoricum
Fig. 32 : Anther filament
Fig. 33 : Ovary
Fig. 34 : Corolla upper surface
Fig. 35 : Style
Fig. 36 : Base of style
Fig. 37 : Corolla lower surface
Fig. 38 : Calyx upper "
Fig. 39 : Stem
Fig. 40 : Leaf



32,33,36,37

34

35

38,39,40

ALL 50 μ

8. Bicellular glandular capitate

Foot : Compound. Body : Differentiated; stalk short, 2-celled, cells broader than long; lateral wall thin and smooth; cross walls thick; lumen wide; content translucent; head large, 1-celled, vesiculate, having several infoldings, hyaline, cell wall thin, content light granulated (Fig. 39).

Distrib. : Stem, Leaf - upper surface (along mid rib), Pedicel, Calyx and Corolla.

9. Brevicollate glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, cell longer than broad; head tricapitate, each 1-celled, globular, hyaline, arranged loosely on the stalk cell; outer wall thin and smooth; content of head light and granulated, and translucent of stalk (Fig. 40).

Distrib. : Stem, Leaf - upper surface, Calyx and Corolla.

Celsia coromandelina

This species shows six types of trichomes (Plate 6, Figs. 41-47).

1. Unicellular clavate

Foot : Not visible. Body : Entire, flagellated, tip rounded and clavate; lateral wall thin and rugose; lumen wide;

content translucent, granulated at tip (Fig. 41).

Distrib. : Corolla, at the place of attachment of Anther filaments.

2. Bicellular aseptate flagellate

Foot : Simple. Body : Differentiated; basal cell short and erect, upper cell much longer, tapering, flagellate; lateral wall thin, rugose; cross wall thin; lumen wide; content translucent (Fig. 42).

Distrib. : Stem.

3. Uniseriate filiform

Foot : Simple. Body : Entire, 3-12 celled, filiform, having light striations, cells longer than broad; lateral wall thin and rugose; cross walls thin; lumen narrow; content granulated. (Fig. 43 & 44).

Distrib. : Stem, Leaf - upper surface, Bract, Pedicel and Calyx.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk very short, 1-celled; head large, 4-celled, cells arranged in one tier; outer wall thin, entire and smooth; content granulated, translucent (Fig. 45).

Distrib. : Leaf - upper surface, and Inflorescence axis.

5. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, lower cell much longer and broader than the upper one, terminal cell appears like collar of the head, lumen wide; content translucent; head globular, vesiculate with hyaline markings; content dark and granulated (Fig. 46).

Distrib. : Stem and Leaf - upper surface.

6. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated, straight or curved, stalk long, 3-4 celled, terminal cell short, collar-like, having granulated, dark contents, lateral wall thin and rugose; cross wall thin; head expanded, multicellular, cells arranged in one vertical tier, content dark (Fig. 47).

Distrib. : Stem, Leaf, Inflorescence, Bract, Pedicel, Calyx and Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 6

Trichomes from various plant parts

Figs. 41-47 : Celsia coronandeliana

Fig. 41 : Corolla base

Fig. 42 : Stem

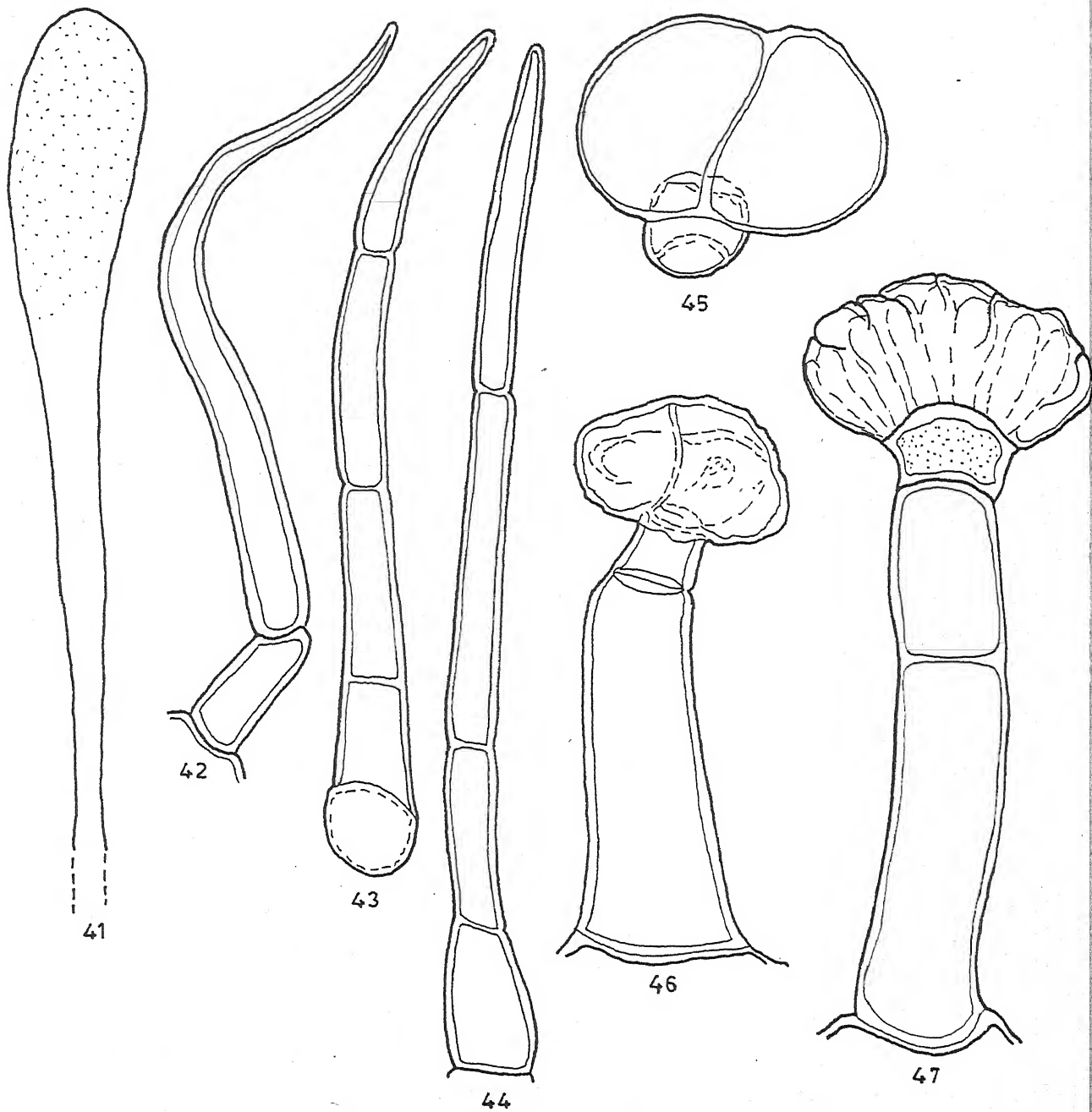
Fig. 43 : Bract

Fig. 44 : Stem

Fig. 45 : Leaf

Figs. 46, 47 : Stem

PLATE-6



41,43,44	_____	} ALL 50μ
42	_____	
45	_____	
46,47	_____	

(b) SERIES - ANTIRRHINIDEAE

Fifty two species belonging to twenty four genera of the series Antirrhinideae have been studied for their trichomes. Structural details of the trichomes and their distribution on various plant parts of the individual species are given below.

Linaria ramosissima

This species shows five types of trichomes (Plate 7, Figs. 1-5).

1. Unicellular papillose

Foot : Simple. Body : Entire, short, papillose, tip rounded; lateral wall thin and smooth; lumen wide; content translucent (Fig. 1).

Distrib. : Stem, Calyx - lower surface and margin, Corolla, base of Style and Ovary.

2. Bicellular filiform

Foot : Simple. Body : Entire, filiform, upper cell of large size, tip rounded; lateral wall thin and smooth; cross wall thick; lumen wide; content yellowish (Fig. 2).

Distrib. : Stem and Ovary.

3. Bicellular cylindrical

Foot : Simple. Body : Entire, erect, upper cell longer than the lower one and gradually narrowing, tip rounded; lateral and cross walls thin and smooth; lumen wide; content yellowish (Fig. 3).

Distrib. : Stem, Petiole, Calyx - lower surface and margin, Corolla and Style - base.

4. Uniseriate cylindrical

Foot : Simple. Body : Entire, 3-4 celled, lower cell short, rectangular, the other one longer than broad, tip rounded; lateral wall thin and smooth; cross walls thin; lumen wide; content yellowish (Fig. 4).

Distrib. : Stem, Leaf - upper surface, Petiole, Calyx - lower surface and margin, Corolla and Ovary.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-4 celled, lower cell short and rectangular, upper cell much longer than broad; head rounded, 4-celled, cells arranged in one tier; outer and lateral walls thin and smooth; cross walls thin; content dark and translucent of head and stalk respectively (Fig. 5).

Distrib. : Stem, Leaf - upper surface, Petiole, Calyx - margin and, Corolla - upper surface.

EXPLANATION OF THE FIGURES OF PLATE - 7

Trichomes from various plant parts

Figs. 1-5 : Linaria romosissima

Fig. 1 : Calyx lower surface

Fig. 2 : Stem

Fig. 3 : Base of style

Fig. 4 : Corolla lower surface

Fig. 5 : Stem

Figs. 6-11 : Linaria vulgaris

Fig. 6 : Corolla lower surface

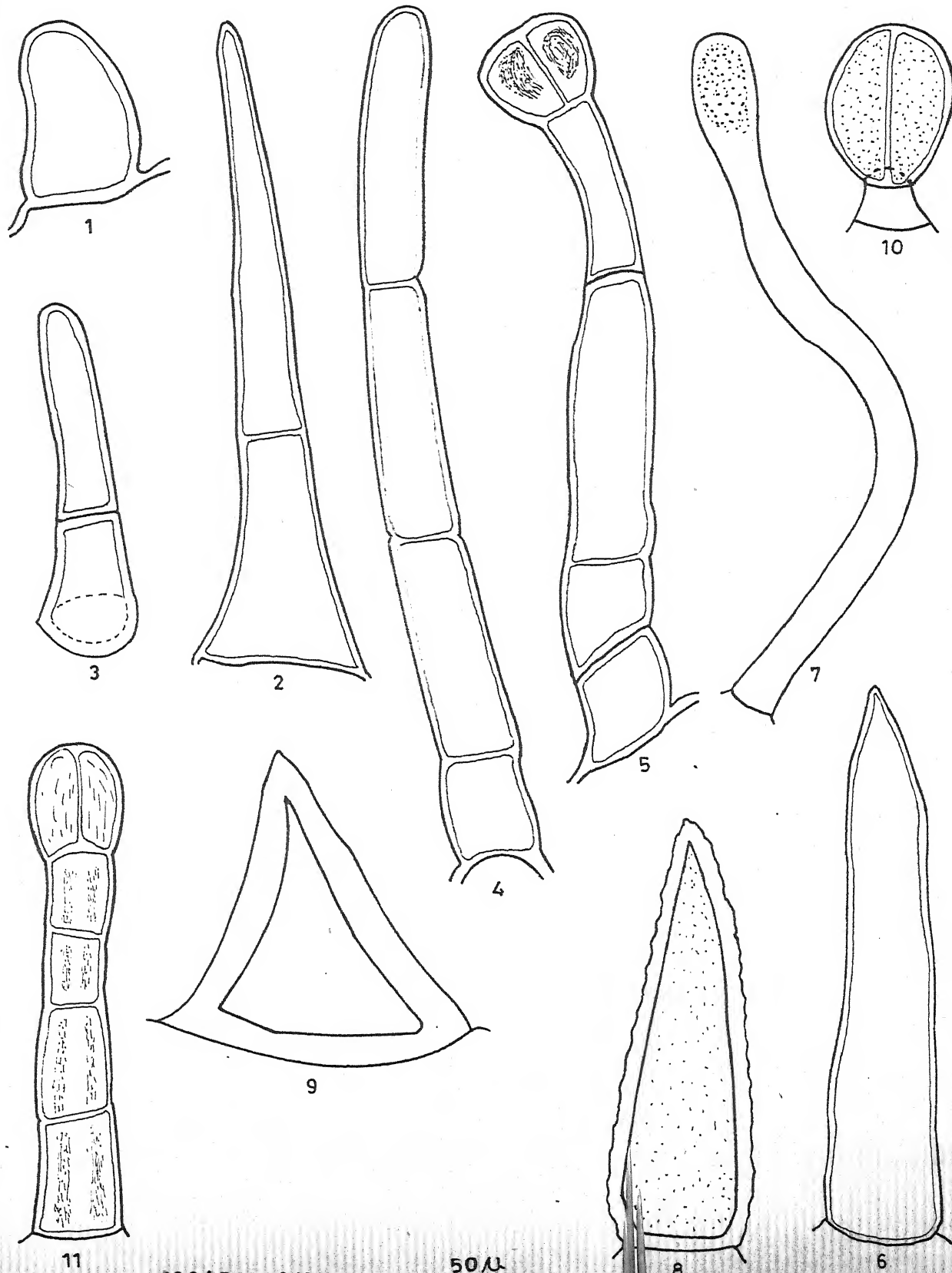
Fig. 7 : Corolla lower "

Fig. 8 : Base of Anther filament

Fig. 9 : Leaf margin

Figs. 10, 11 : Calyx margin

PLATE-7



12,3,4,5,6,7,8,9,10,11

50μ

Linaria vulgaris

This species shows six types of trichomes
(Plate 7, Figs. 6-11).

1. Unicellular papillose

Foot : Simple. Body : Entire, hyaline, tip pointed; wall thin, smooth or rugose; lumen wide; content translucent (Fig. 6).

Distrib. : Corolla - lower surface.

2. Unicellular clavate

Foot : Simple. Body : Entire, tubular, flagellate, tip clavate; wall thin and smooth; lumen wide; content translucent (Fig. 7).

Distrib. : Corolla - lower surface.

3. Unicellular conical

Foot : Simple. Body : Entire, short, erect, tip pointed; wall thick and verrucose; lumen wide; content granulated opaque (Fig. 8).

Distrib. : Calyx - lower surface and margin and Anther filaments.

4. Unicellular dentate

Foot : Simple. Body : Entire, dentate, broad base, tip pointed, wall thick and smooth; lumen wide; content translucent

(Fig. 9)

Distrib. : Leaf - margin.

5. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short collar-like; head oval, 4-celled, elongated cells arranged lengthwise in one tier; outer wall thin and smooth; content granulated translucent (Fig. 10).

Distrib. : Calyx - upper surface & margin.

4. Uniseriate granular capitate

Foot : Simple. Body : Erect, differentiated; stalk 3-4 celled, cells cubical; head short, rounded, 4-celled; cells arranged in one tier lengthwise, lateral and outer walls thin and smooth; cross walls thin; content dark, granulated throughout the body (Fig. 11).

Distrib. : Calyx - margin.

Kickxia subsessilis

This species shows seven types of trichomes
(Plate 8, Figs. 12-20).

1. Unicellular flagellate

Foot : Not visible. Body : Entire long, hyaline, flagellate, tip rounded; wall thin and smooth; lumen various; content

translucent (Fig. 12).

Distrib. : Corolla - lower surface, at the place of attachment of Anther filament.

2. Unicellular cylindrical

Foot : Simple. Body : Entire, long or stout, cylindrical, tip rounded (Fig. 13) or truncate (Fig. 14); wall thin or thick, smooth; lumen wide; content translucent (Figs. 13 & 14).

Distrib. : Stem, Leaf & Calyx - upper surface & margin, and Corolla - margin.

3. Unicellular curved

Foot : Simple. Body : Entire, curved, tip rounded; wall thick and smooth; lumen wide; content translucent (Fig. 15).

Distrib. : Leaf - margin.

4. Bicellular cylindrical

Foot : Simple. Body : Entire, slightly curved on one side, upper cell longer than the lower one, tip truncate; lateral wall thin and smooth, cross wall thin; lumen wide; content translucent (Fig. 16).

Distrib. : Stem, Leaf, & Calyx - margin.

5. Uniseriate filiform

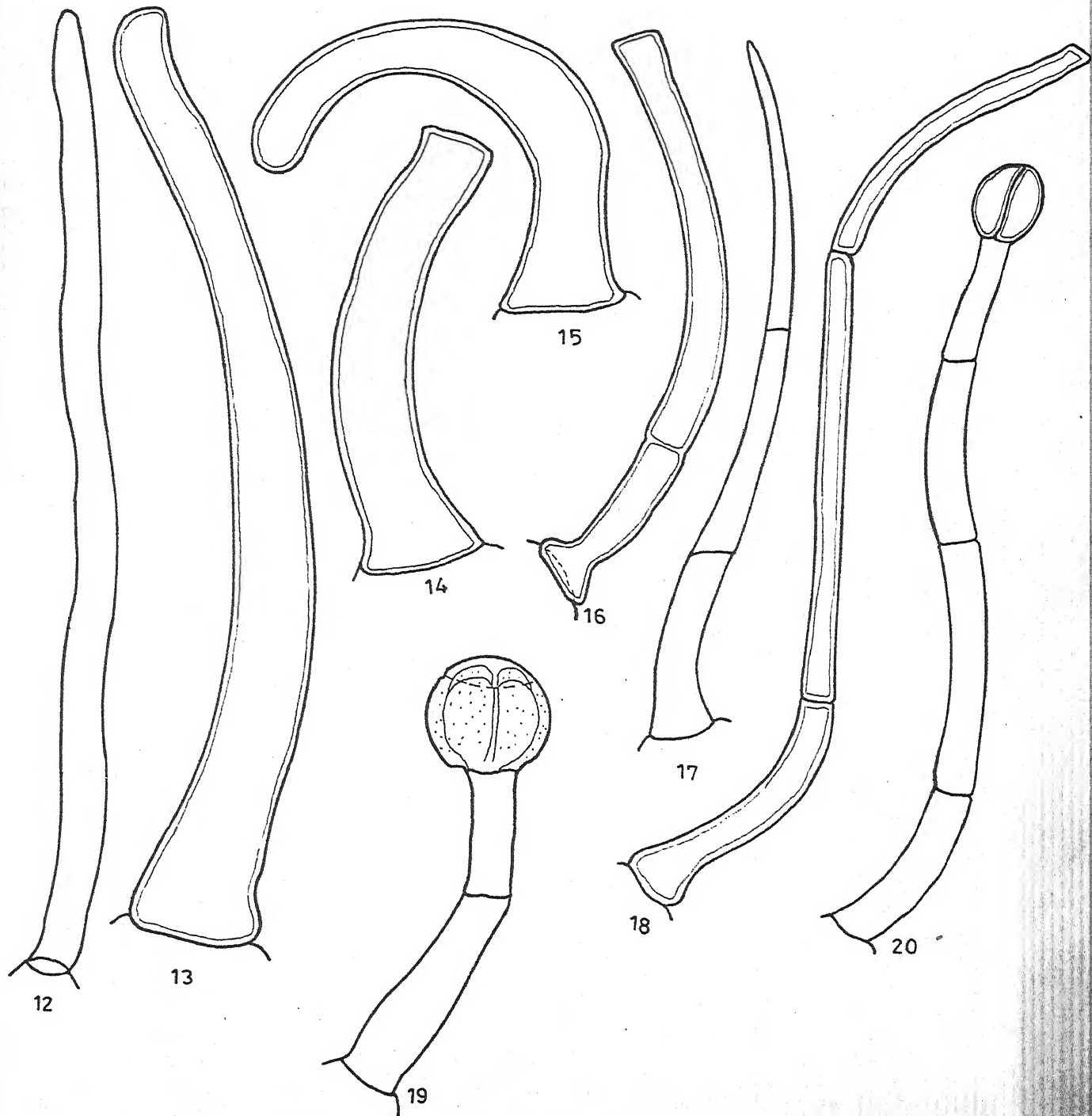
Foot : Simple. Body : Entire, 3-celled, cells much longer than broad, tip rounded (Fig. 17) or truncate (Fig. 18);

EXPLANATION OF THE FIGURES OF PLATE - 8

Trichomes from various plant parts

- Figs. 12-20 : Kickxia subsessilis
Fig. 12 : Corolla lower surface
Fig. 13 : Leaf margin
Fig. 14 : Stem
Fig. 15 : Leaf margin
Fig. 16 : Stem
Fig. 17 : Stem
Fig. 18 : Leaf upper surface
Fig. 19 : Stem
Fig. 20 : Leaf margin

PLATE-8



12,13,15,17,19,20

14,16,18

ALL 50 μ

lateral wall thin and smooth; cross walls thin, lumen narrow; content translucent (Figs. 17 & 18).

Distrib. : Stem, Leaf, & Calyx - upper surface & margin.

6. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 2-celled cells much longer than broad; head large, globular & multicellular; cells arranged in a single whorl; walls thin and smooth; lumen wide; content of stalk translucent, and of head granulated (Fig. 19).

Distrib. : Stem.

7. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk hyaline, 3-5 celled, long, cells longer than broad; head small, globular, 4-celled; walls thin and smooth; lumen narrow; content granulated of head and translucent that of stalk (Fig. 20).

Distrib. : Stem & Leaf margin.

Antirrhinum orontium

This species shows 2 types of trichomes (Plate 9, Figs. 21 & 22).

1. Unicellular clavate

Foot : Not visible. Body : Entire, long, hyaline, flexuous, distal end club-shaped; wall thin and smooth; lumen wide;

content translucent, granulated in the upper region (Fig. 21).

Distrib. : Corolla - lower surface.

2. Uniseriate glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk long, 3-6 celled, cells longer than broad, basal cell somewhat pulvinus; lateral wall thin and smooth; head 4-celled, cells elongated, arranged in one vertical tier; outer wall vesiculate; content dark and granulated of head and translucent that of stalk cells (Fig. 22).

Distrib. : Stem, Leaf base, Bracteole, Calyx, Style, and Ovary.

Antirrhinum majus

This species shows three types of trichomes (Plate 9, Figs. 23-25).

1. Unicellular papillose

Foot : Simple. Body : Erect, papillose, tip broadly rounded; wall thin and smooth; lumen wide; content translucent (Fig. 23).

Distrib. : Anther - base of the filament.

2. Uniseriate cylindrical

Foot : Simple. Body : Entire, straight, 3-5 celled, cells longer than broad, tip broadly rounded, verrucose; lateral

wall thin and smooth, cross walls thin and appear ring like; content translucent (Fig. 24).

Distrib. : Calyx - upper surface.

3. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-5 celled, cells longer than broad, basal one much broadened at base; head oval to rounded, multicellular, appears as seated on the stalk, cells of varied shape and size arranged in a vertical tier; outer wall vesiculate; lateral wall thin and smooth; cross walls thick; content translucent of stalk and dark granulated of head cells (Fig. 25).

Distrib. : Stem, Leaf - upper surface & margin, Inflorescence axis, Pedicel, Calyx, Corolla, Anther filaments, Style, and Ovary.

Scrophularia calycina

This species shows four types of trichomes (Plate 9, Figs. 26-29).

1. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, very short; head large, globular, 2-4 celled, cells arranged in one tier; outer wall thin and smooth; content translucent (Fig. 26).

Distrib. : Stem, Leaf (young) & Calyx - upper surface, Corolla and Anther filaments.

2. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, basal cell much longer and wider, upper one short, like collar of the head; head large 1-celled, with longitudinal hyaline striations; outer and lateral wall thin and smooth; content granulated of head and collared cell, translucent that of basal stalk cell (Fig. 27).

Distrib. : Leaf, Calyx, and Corolla - upper surface.

3. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-4 celled; cells longer and wider, except terminal collared one; head globular, large, 1-celled, outer and lateral wall thin and smooth; cross walls thick; lumen wide; content translucent (Fig. 28).

Distrib. : Stem, Leaf and Corolla - upper surface.

4. Brevicollate glandular capitate

Foot : Simple. Body : Differentiated; stalk very short, 1-celled; head having two separate, rounded, hyaline glandular cells, directly on the stalk cell, outer wall thin and smooth; content translucent of head cells and opaque of stalk cell (Fig. 29).

Distrib. : Leaf - upper surface, and Corolla.

Scrophularia urticaefolia

This species shows seven types of trichomes
(Plate 9, Figs. 30-36).

1. Unicellular papillose

Foot : Simple. Body : Short, papillose, tip rounded; wall thin and smooth; lumen wide; content granulated, with light striations (Fig. 30).

Distrib. : Calyx - margin.

2. Bicellular cylindrical

Foot : Simple. Body : Short, cylindrical, cells hyaline, longer than broad, tip rounded; lateral wall thin and smooth; lumen wide; content translucent (Fig. 31).

Distrib. : Calyx - lower surface & margin.

3. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short and broad, 1-celled; head larger, multi-cellular, fitted on the stalk, cells oval, spread in a fan-like fashion, arranged in one tier; outer wall thin and convex; content of head dark granulated (Fig. 32).

Distrib. : Anther filaments.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 2-celled, basal cell much longer than short, terminal, collared one, content translucent; head globular, 4-celled; outer wall thin and smooth; content granulated (Fig. 33).

Distrib. : Bract. young flower bud and Anther.

5. Uniseriate glandular

Foot : Simple. Body : 3-celled lower two cells cubical, terminal cell enlarged, globular; wall thick and smooth; content granulated except sub-terminal collared cell (Fig. 34).

Distrib. : Calyx margin.

6. Uniseriate glandular capitate

Foot : Compound. Body : Differentiated; stalk long, 3-8 celled, cells much elongated, cylindrical, except terminal short collared cell; head sub-globose, 4-celled, cells arranged in one tier; outer and lateral wall thin and smooth; cross walls thick; lumen wide; content translucent (fig. 35).

Distrib. : Leaf - upper surface & margin, Bract., and Pedicel.

7. Brevicollate glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled; head with two globular cells; outer wall thin and smooth; content granulated (Fig. 36).

EXPLANATION OF THE FIGURES OF PLATE - 9

Trichomes from various plant parts

Figs. 21-22 : Antirrhinum orontium

Fig. 21 : Corolla lower surface

Fig. 22 : Stem

Figs. 23-25 : Antirrhinum majus

Fig. 23 : Base of anther filament

Fig. 24 : Calyx upper surface

Fig. 25 : Stem

Figs. 26-29 : Scrophularia calycina

Fig. 26 : Leaf upper surface

Fig. 27 : Calyx lower "

Fig. 28 : Stem

Fig. 29 : Leaf upper surface

Figs. 30-36 : Scrophularia urticaefolia

Fig. 30 : Calyx margin

Fig. 31 : Calyx margin

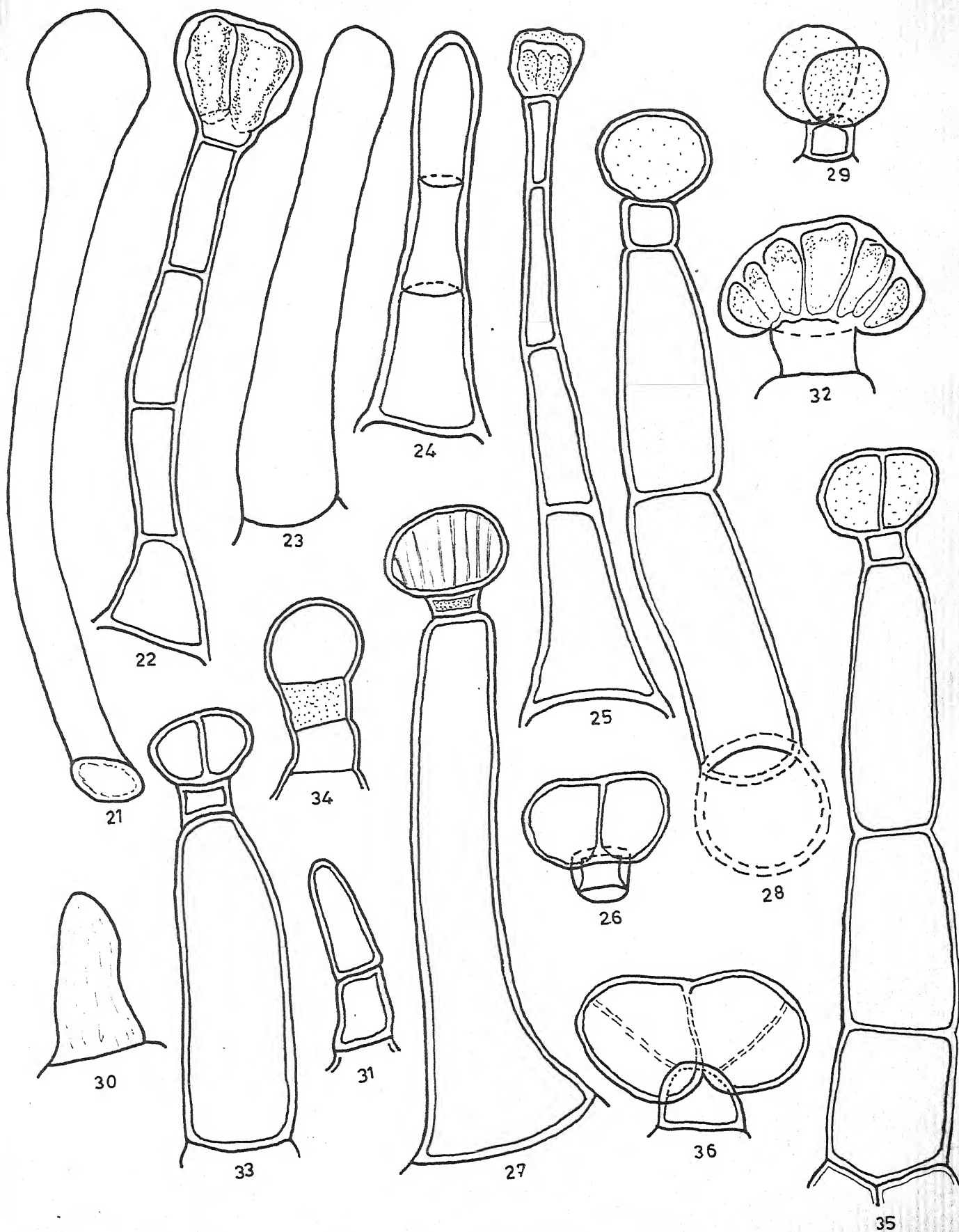
Fig. 32 : Anther filament

Fig. 33 : Bract

Fig. 34 : Calyx margin

Fig. 35 : Leaf margin

Fig. 36 : Bract



21,22,26,28,29,30,31,34,35

23,24,25,27

32,33,36

ALL 50 μ

Distrib. : Leaf - upper surface, Pedicel, Calyx - margin and Anther filaments.

Scrophularia polyantha

This species shows four types of trichomes
(Plate 10, Figs. 37-43).

1. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, cell longer than broad; head small, globular, emarginate, 4-celled, cells arranged in one tier; outer wall thin and smooth; content translucent (Fig. 37).

Distrib. : Stem.

2. Bicellular glandular capitate

Foot : Simple or compound. Body : Differentiated; stalk 2-celled, lower cell much longer than upper short collared one (Fig. 38), or equal sized (Fig. 39); head 1-celled, hyaline, inflated, irregularly rounded (Fig. 38), or large, 4-celled (Fig. 39); wall thin and smooth; lumen wide; content translucent of stalk cell and dark granulated of head and collared cells (Figs. 38 & 39).

Distrib. : Stem, Pedicel, and Corolla.

3. Uniseriate glandular capitate

Foot : Simple or compound. Body : Differentiated; stalk 3-5 celled of varying length, cells cubical or rectangular or much longer than broad; lateral wall thin and smooth, or striated; lumen wide; content translucent or dark granulated; head unicellular or multicellular, of varied shapes, either oblong having depressed cells in uniseriate fashion (Fig. 40), or biseriate collateral (Fig. 41), or small, globular, 1-celled and seated on short collared cell (Fig. 42); outer wall smooth or irregular; content granulated (Figs. 40-42).
Distrib. : Leaf and Anther filaments.

4. Brevicollate glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, with broad base; head with two globular cells; outer wall thin and smooth; content translucent of head cells and, dark that of stalk (Fig. 43).
Distrib. : Stem.

Scrophularia decomposita var typica

This species shows two types of trichomes
(Plate 10, Figs. 44-47).

1. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short (Figs. 44 & 46) or long, cylindrical (Fig. 45); head large.

globular, cordate, or irregularly shaped, 1-celled (Fig. 44), or 4-celled (Fig. 46), or many celled (Fig. 45); outer wall thin and smooth; content translucent or light granulated (Figs. 44-46).

Distrib. : Stem, Leaf - lower surface & margin, Pedicel, Bracteole, Calyx, and Corolla - lower surface.

2. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk many celled, cells of varying size, lateral wall thin and smooth, cross walls thin, content translucent; head oblong, multicellular, discoid, cells arranged in uniseriate manner, outer wall undulate, irregular; content dark and granulated (Fig. 47).

Distrib. : Anther filaments.

Scrophularia decomposita asp. latifolia

This species shows four types of trichomes (Plate 10, Figs. 48-52).

1. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled; head large, 4-celled, cells large, arranged in one tier, outer wall thin and smooth, with an apical papilla; content granulated, translucent (Fig. 48).

Distrib. : Bract.

2. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, basal cell much longer and broader than upper short collared cell; head large, 4-celled, cells arranged in one tier; outer wall thin and smooth with an apical papilla (Fig. 49), or gland having stalk of two equal sized rectangular cells and head; head oblong, multicellular, short segmented; cells arranged in uniseriate fashion (Fig. 50); lateral wall thin and smooth; lumen wide; content of head and collared cell granulated, dark and translucent of basal stalk cell (Fig. 49 & 50).

Distrib. : Stem, Leaf lower surface and margin, Corolla - lower surface and Anther filaments.

3. Bicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk 2-celled, basal cell longer than upper short collared one; head inflated, large, 1-celled, outer wall thin, hyaline and vesiculate, revealing several infoldings; lateral wall thin and smooth; lumen wide; content of head dark granulated, and translucent of stalk (Fig. 51).

Distrib. : Bract, Pedicel and Calyx.

4. Brevicollate glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head with hyaline rounded cells; outer wall thin

EXPLANATION OF THE FIGURES OF PLATE - 10

Trichomes from various plant parts

Figs. 37-43 : Scrophularia polyantha

Fig. 37 : Stem

Fig. 38 : Flower pedicel

Fig. 39 : Corolla lower

Fig. 40 : Anther filament

Fig. 41 : Anther filament

Fig. 42 : Leaf upper surface

Fig. 43 : Stem

Figs. 44-47 : Scrophularia decomposita var. typica

Fig. 44 : Leaf

Fig. 45 : Leaf margin

Fig. 46 : Stem

Fig. 47 : Anther filament

Figs. 48-52 : Scrophularia decomposita ssp. latifolia

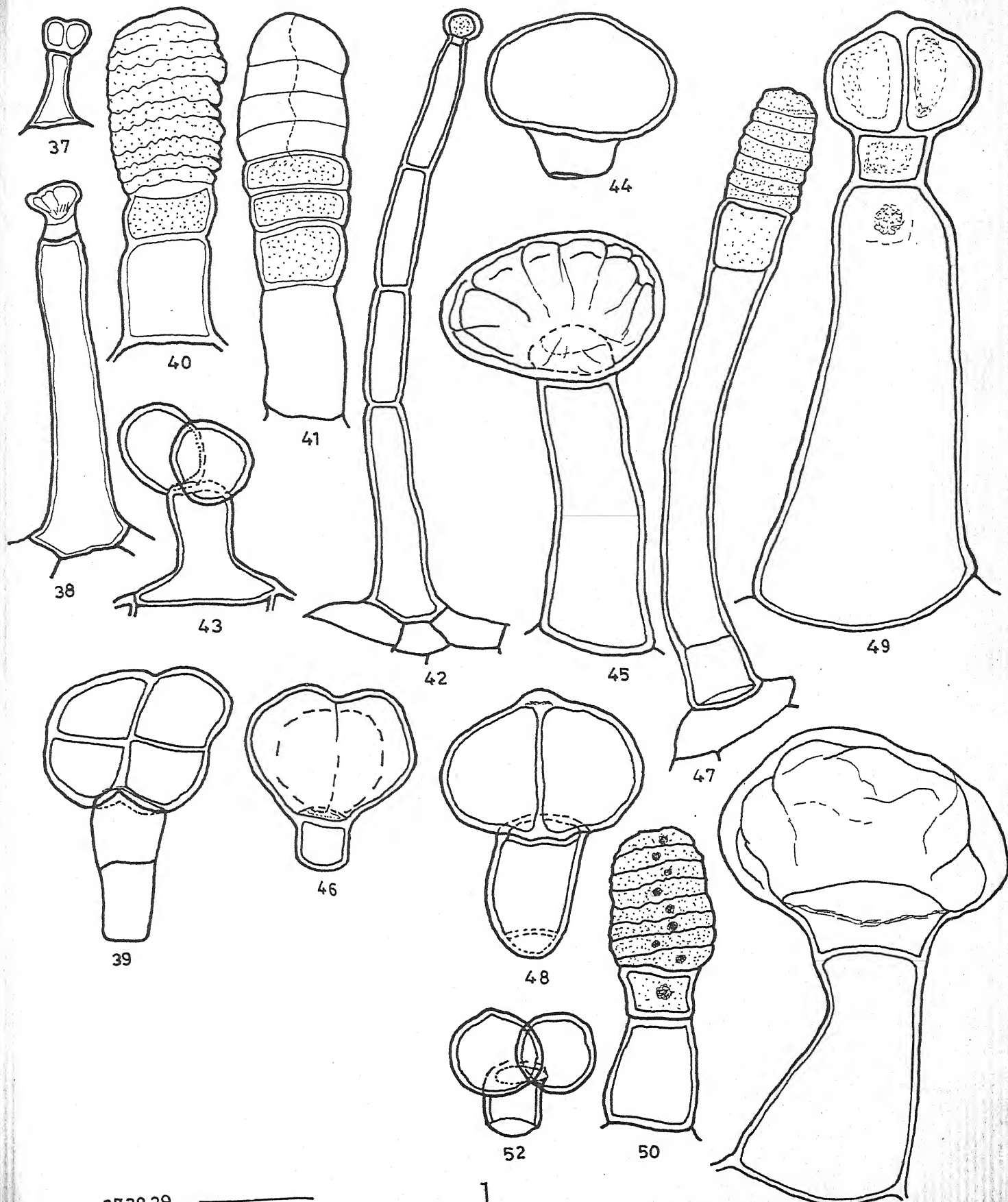
Fig. 48 : Bract

Fig. 49 : Stem

Fig. 50 : Anther filament

Fig. 51 : Flower pedicel

Fig. 52 : Calyx



37, 38, 39
40, 41, 43, 45, 47,
48, 49, 50, 51, 52

42
44, 46

ALL 50 μ

and smooth content granulated of head cells, translucent of the stalk (Fig. 52).

Distrib. : Bract, Pedicel and Calyx.

Sutera glandulosa

This species shows three types of trichomes (Plate 11, Figs. 53-55).

1. Unicellular hooked

Foot : Simple. Body : Entire, upper part curved, tip pointed; wall thick and smooth; lumen wide; content translucent (Fig. 53).

Distrib. : Stem.

2. Peltate glandular

Foot : Not visible. Body : Multicellular sessile disc, cells parallel to epidermis, radiating from common center; outer wall smooth and thick; content granulated yellowish (Fig. 54).

Distrib. : Stem, Leaf, Bract, Calyx, Corolla, and Ovary wall.

3. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 2-celled, lower cell much longer than upper short collared cell;

head large, multicellular, tips infolded to form pouch-like structure; lateral wall thin and smooth; content dark of head, and translucent that of stalk (Fig. 55).

Distrib. : Stem.

Mimulus nepalensis

This species shows eight types of trichomes (Plate 11, Figs. 56-63).

1. Unicellular clavate

Foot : Not visible. Body : Entire, tip swollen, club-shaped; lateral wall thin rugose and warty; lumen wide; content dark granulated (Fig. 56).

Distrib. : Corolla - lower surface at the point of attachment of Anther filaments.

2. Unicellular conical

Foot : Simple. Body : Entire, tapering to a point, base spread; lateral wall thin and rugose; lumen wide, content translucent or light granulated (Fig. 57).

Distrib. : Leaf - lower surface, margin & apex, and Corolla.

3. Unicellular cylindrical

Foot : Simple. Body : Entire, long, cylindrical, tip rounded; lateral wall thin and smooth; lumen wide;

content translucent (Fig. 58).

Distrib. : Corolla - lower surface.

4. Unicellular dentate

Foot : Simple. Body : Entire, short, dentate, striated; lateral wall thick and smooth; lumen wide; content granulated, translucent (Fig. 59).

Distrib. : Corolla - margin.

5. Bicellular filiform

Foot : Simple. Body : 2-celled, filiform, upper cell longer and narrower than lower one, tip rounded, joint articulate; lateral wall thin and smooth; lumen wide; content translucent (Fig. 60).

Distrib. : Corolla - lower surface.

6. Uniseriate conical

Foot : Simple. Body : Entire, 3-6 celled, slightly curved conical, cells longer than broad, tip pointed; lateral wall thin and rugose; content yellow, granulated (Fig. 61).

Distrib. : Stem, Petiole, Leaf - lower surface along mid rib.

7. Peltate glandular

Foot : Not visible. Body : Peltate, 4-celled, sessile, 1-celled thick, cells parallel to epidermis, opposed to

each other, outer wall thin, smooth and convex; content light (Fig. 62).

Distrib. : Stem, Leaf, Bract, Pedicel, Calyx, and Corolla - upper surface.

8. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-5 celled, erect, cells longer than broad, except short terminal collared cell; head, 4-celled, rounded; wall thin and smooth; cross walls thin; lumen wide; content dark of head and collared cell, translucent of other stalk cells (Fig. 63).

Distrib. : Bract, and Pedicel.

Mimulus gracilis

This species shows five types of trichomes (Plate 11, Figs. 64-69).

1. Unicellular papillose

Foot : Not visible. Body : Entire, tubular, tip club-shaped; wall thin and smooth; lumen wide; content translucent (Fig. 64).

Distrib. : Corolla - lower surface.

2. Unicellular conical

Foot : Compound. Body : Entire, short conical, tapering to a point; wall thick and smooth; lumen wide; content translucent (Fig. 65).

Distrib. : Corolla - lower surface.

3. Unicellular cylindrical

Foot : Simple. Body : Entire, stiff, erect, or flexuous, tip rounded; lateral wall thin or thick and smooth; lumen narrow (Fig. 66) or wide (Fig. 67); content translucent (Figs. 66 & 67).

Distrib. : Calyx and Corolla - lower surface.

4. Unicellular dentate

Foot : Simple. Body : Entire, short, dentate, tip pointed; lateral wall thick and smooth; lumen wide; content evanescent (Fig. 68).

Distrib. : Leaf - margin.

5. Peltate glandular

Foot : Not visible. Body : Multicellular, sessile disc of 1-celled thickness, parallel to epidermis; outer wall thin, smooth and convex; content translucent (Fig. 69).

Distrib. : Stem and Leaf.

EXPLANATION OF THE FIGURES OF PLATE - 11

Trichomes from various plant parts

Figs. 53-55 : Sutera glandulosa

Fig. 53 : Stem

Fig. 54 : Corolla

Fig. 55 : Stem

Figs. 56-63 : Mimulus nepalensis

Fig. 56 : Corolla lower surface

Fig. 57 : Leaf margin

Fig. 58 : Corolla lower surface

Fig. 59 : Corolla margin

Fig. 60 : Corolla lower surface

Fig. 61 : Stem

Fig. 62 : Flower pedicel

Fig. 63 : Bract

Figs. 64-69 : Mimulus gracilis

Fig. 64 : Corolla lower surface

Fig. 65 : Calyx margin

Fig. 66 : Calyx upper surface

Fig. 67 : Corolla lower "

Fig. 68 : Leaf lower "

Fig. 69 : Stem

EXPLANATION OF THE FIGURES OF PLATE - 11

Trichomes from various plant parts

Figs. 53-55 : Sutera glandulosa

Fig. 53 : Stem

Fig. 54 : Corolla

Fig. 55 : Stem

Figs. 56-63 : Mimulus nepalensis

Fig. 56 : Corolla lower surface

Fig. 57 : Leaf margin

Fig. 58 : Corolla lower surface

Fig. 59 : Corolla margin

Fig. 60 : Corolla lower surface

Fig. 61 : Stem

Fig. 62 : Flower pedicel

Fig. 63 : Bract

Figs. 64-69 : Mimulus gracilis

Fig. 64 : Corolla lower surface

Fig. 65 : Calyx margin

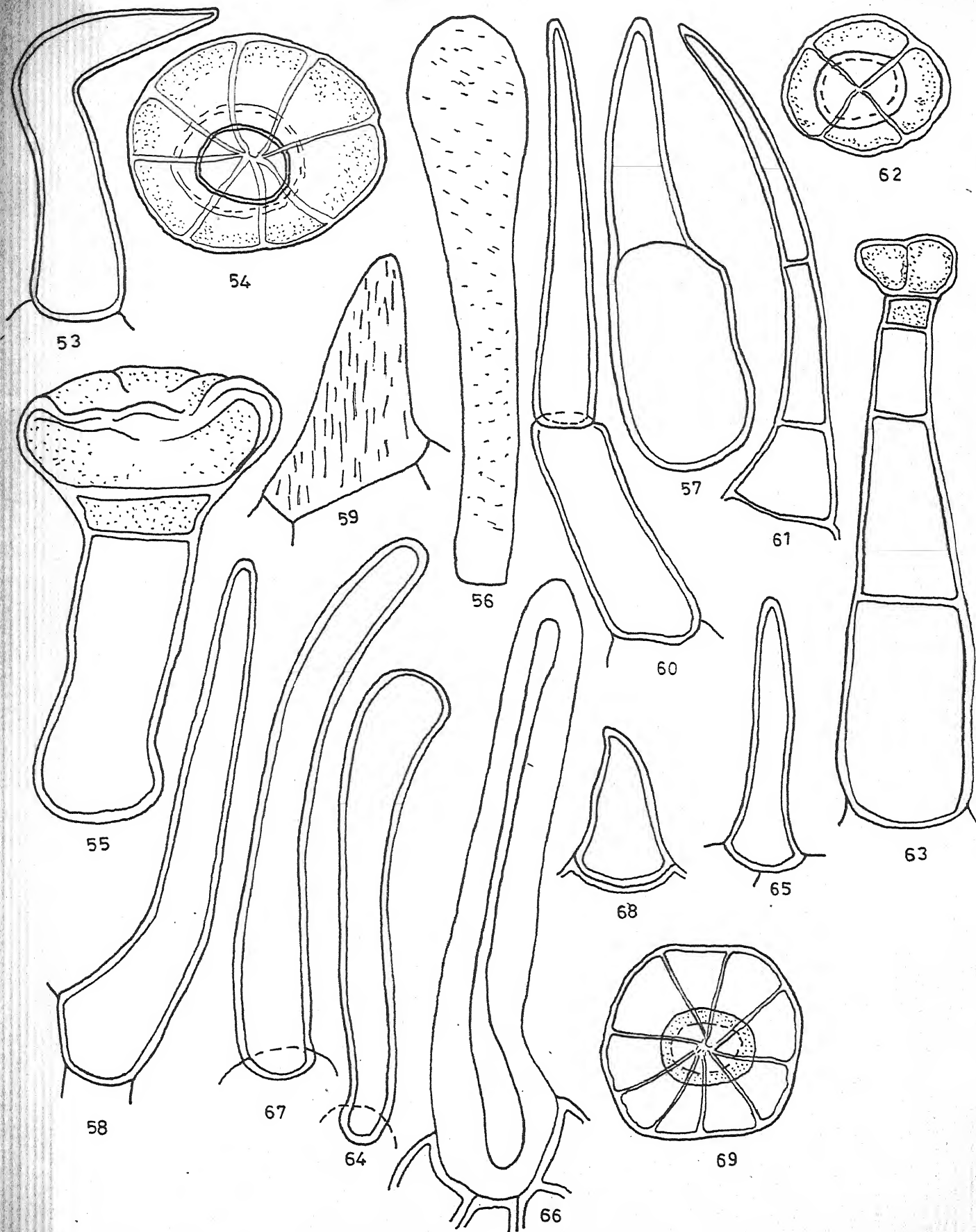
Fig. 66 : Calyx upper surface

Fig. 67 : Corolla lower "

Fig. 68 : Leaf lower "

Fig. 69 : Stem

PLATE-11



53,54,55,62,66,69

56,57,58,59,60,63,64,65,67,68

61

ALL 50 μ

Mimulus luteus

This species shows six types of trichomes
(Plate 12, Figs. 70-75).

1. Unicellular papillose

Foot : Not visible. Body : Entire, erect, hyaline, club-shaped, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 70).

Distrib. : Corolla - lower surface.

2. Unicellular flagellate

Foot : Not visible. Body : 1-celled flagellate, tip constricted and knobbed; wall thin or thick and smooth; lumen narrow except at base; content (Fig. 71).

Distrib. : Calyx.

3. Unicellular acuminate

Foot : Not visible. Body : Entire, erect, acuminate, tip pointed; wall thick and smooth; lumen narrow except at base; content opaque or translucent (Fig. 72).

Distrib. : Calyx.

4. Peltate porous glandular

Foot : Not visible. Body : Peltate, sessile, 7-9 celled disc, parallel to epidermis; cells arranged around the

hollow center; wall thin and smooth; content dark and granulated (Fig. 73).

Distrib. : Leaf.

5. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short, broader than long, content dark; head large, flattened, hyaline, 1-celled; outer wall thin and rough; content light granulated (Fig. 74).

Distrib. : Style and Ovary.

6. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, lower cell much longer and broader than upper very short-collared cell; head large, irregularly inflated, 1-celled; outer wall thin and smooth; lumen wide; content light granulated of head, dark of collared cell (Fig. 75).

Distrib. : Stem, Pedicel, and Calyx - lower surface & margin.

Mazus jaconicus

This species shows five types of trichomes (Plate 12, Figs. 76-81).

1. Unicellular clavate

Foot : Simple. Body : Entire, erect, or flexuous, tip

swollen, club-shaped; wall thin and rugose; lumen narrow except at the tip; content dark granulated (Fig. 76).

Distrib. : Corolla - lower surface.

2. Unicellular cylindrical

Foot : Simple. Body : Entire, cylindrical, tip rounded, base spread; wall thin and smooth; lumen wide; content translucent, nucleated at base (Fig. 77).

Distrib. : Stem.

3. Unicellular dentate

Foot : Simple. Body : Entire, short, dentate, striated, tip pointed; wall thick and smooth; lumen wide; content dark granulated (Fig. 78).

Distrib. : Corolla - margin.

4. Uniseriate conical

Foot : Simple. Body : Entire, 3-celled, conical; tip pointed; cells rectangular; wall thick and smooth; cross walls thick; lumen wide; content dark (Fig. 79).

Distrib. : Stem, Inflorescence axis, and Pedicel.

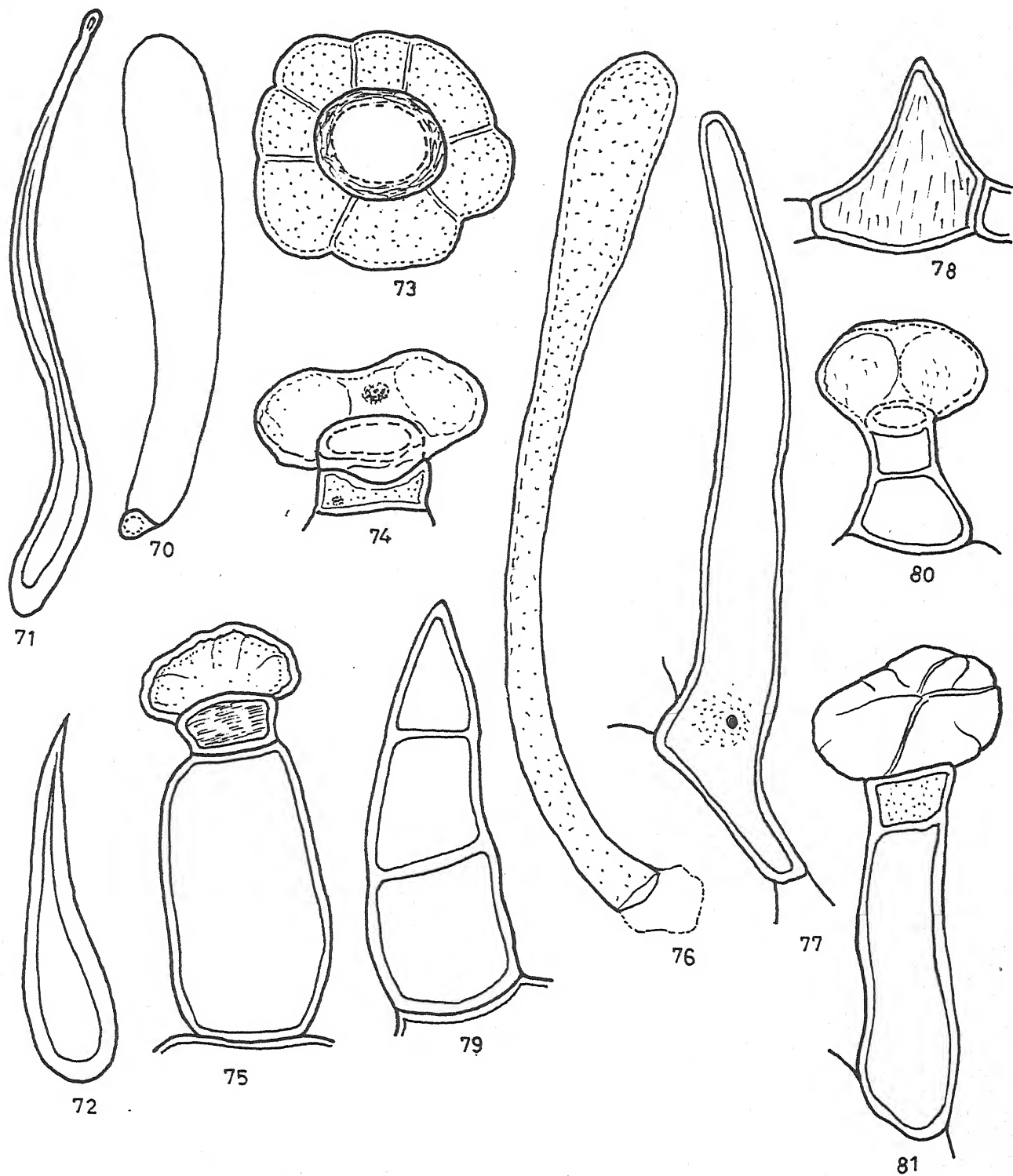
5. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, cells short and equal size or lower cell much longer than upper short, collared cell; head 4-celled, large rounded,

EXPLANATION OF THE FIGURES OF PLATE - 12

Trichomes from various plant parts

- Figs. 70-75 : Mimulus luteus
Fig. 70 : Corolla lower surface
Fig. 71 : Calyx upper "
Fig. 72 : Calyx margin
Fig. 73 : Leaf upper surface
Fig. 74 : Style
Fig. 75 : Stem
- Figs. 76-81 : Mazus japonicus
Fig. 76 : Corolla lower surface
Fig. 77 : stem
Fig. 78 : Corolla margin
Fig. 79 : Inflorescence axis
Fig. 80 : Flower pedicel
Fig. 81 : Inflorescence axis



70, 72	_____	} ALL 50 μ
71	_____	
73, 74	_____	
75, 76, 77, 78, 79, 80, 81	_____	

or flattened, outer and lateral walls thin and smooth; cross wall thick; lumen wide; content dark of head and collared cell, translucent of lower stalk cell (Figs. 80 & 81).

Distrib. : Inflorescence axis, Pedicel, Calyx, and Corolla.

Mazus surculosus

This species shows three types of trichomes (Plate 13, Figs. 82-84).

1. Uniseriate conical

Foot : Simple. Body : Entire, 5-11 celled, cells almost rectangular, tip pointed; lateral wall thin, smooth, convex and constricted at joints; cross walls thick; lumen wide; content translucent or opaque (Fig. 82).

Distrib. : Leaf, Petiole and Calyx.

2. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head 4-celled, hyaline, cells arranged in cruciate fashion; lateral and outer wall thin and smooth, lumen wide; content of stalk dark and translucent than that of head cells (Fig. 83).

Distrib. : Petiole, Leaf - upper surface (along mid rib), Bract, Pedicel and Calyx.

3. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long 3-5 celled, lower cells longer than upper rectangular ones; head multicellular, convex, flattened discoid form, consisting of varying number of cells arranged in a single layer, like an umbrella; lateral wall thin and smooth; cross walls thin; lumen wide; content translucent of stalk, and granulated of head (Fig. 84).

Distrib. : Bract, Pedicel, Calyx - upper surface & margin, and Corolla - lower surface.

Mazus dentatus

This species shows five types of trichomes (Plate 13, Figs. 85-89).

1. Unicellular clavate

Foot : Simple. Body : Entire, short, tip swollen, club-shaped; wall thin and smooth; lumen wide, content translucent with few granules (Fig. 85).

Distrib. : Corolla - lower surface and margin.

2. Uniseriate filiform

Foot : Simple. Body : 5-16 celled, very long; cells longer than broad, tip rounded; lateral wall thick and smooth, straight or convex; cross walls thin; lumen wide; content

translucent (Fig. 86).

Distrib. : Stem, Petiole, Leaf - lower surface, and Calyx.

3. Uniseriate conical

Foot : Simple. Body : Entire, 5-10 celled, conical, cells rectangular, tip pointed; lateral wall thick, convex and constricted at joints; cross walls thick; lumen wide, content translucent (Fig. 87).

Distrib. : Leaf - upper surface.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head hyaline, large, 1-celled, rounded, outer wall thin and smooth; lumen wide; content dark of stalk, and translucent that of head (Fig. 88).

Distrib. : Stem and Leaf.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 4-7 celled; cells longer than broad except terminal, short collared one; head unicellular, globular, or with apical notch; lateral wall thin and smooth, cross walls thin; lumen wide; content dark of collared cell, light granulated of head, and translucent that of remaining stalk cells (Fig. 89).

Distrib. : Calyx - lower surface.

Mazus pumilus

This species shows three types of trichomes
(Plate 13, Figs. 90-93).

1. Unicellular papillose

Foot : Simple. Body : Entire, short with broad base, tip rounded (Fig. 90), or body inflated (Fig. 91); wall thin and smooth; lumen wide; content translucent (Figs. 90 & 91).
Distrib. : Leaf - margin, and Corolla - upper surface.

2. Uniseriate conical

Foot : Simple. Body : Entire, 3-5 celled, short, pyramidal, cells broader than longer except the terminal having a long beak, tip pointed; lateral wall thin, convex, smooth and constricted at joints; cross walls thin; lumen wide; content translucent (Fig. 92).

Distrib. : Stem, Leaf - margin, and Calyx - upper surface.

3. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated, stalk 2-3 celled long, basal cell longer than upper ones; head larger, multicellular, undulated, spherical, cells arranged in a rosette; walls thin and smooth; lumen wide; content dark except basal stalk cell (Fig. 93).

Distrib. : Stem, Inflorescence axis, and Pedicel.

EXPLANATION OF THE FIGURES OF PLATE - 13

Trichomes from various plant parts

Figs. 82-84 : Mazus surculosus

Fig. 82 : Leaf margin

Fig. 83 : Petiole

Fig. 84 : Flower pedicel

Figs. 85-89 : Mazus dentatus

Fig. 85 : Corolla lower surface

Fig. 86 : Calyx lower "

Fig. 87 : Leaf upper "

Fig. 88 : Stem

Fig. 89 : Calyx lower surface

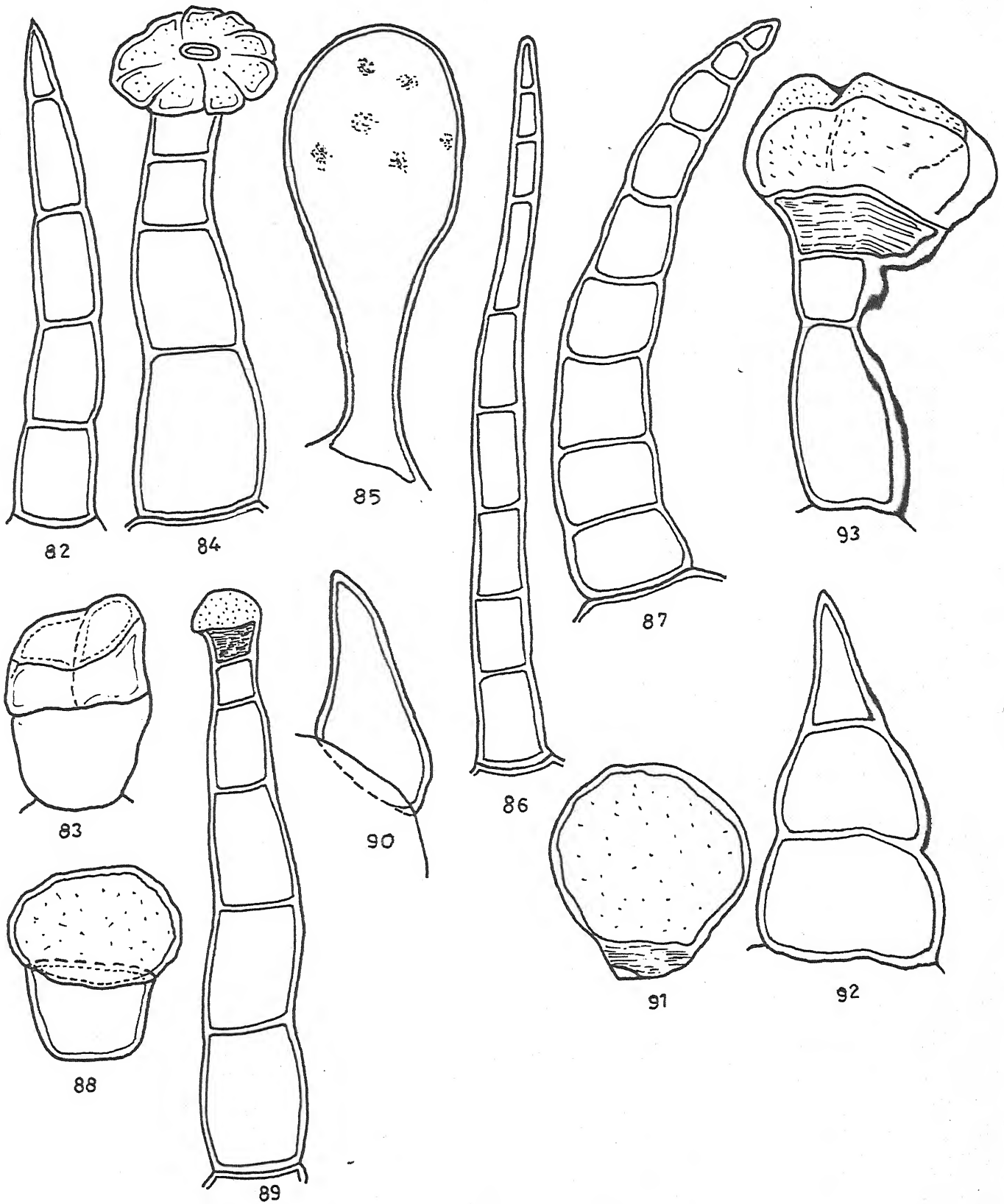
Figs. 90-93 : Mazus pumilus

Fig. 90 : Leaf margin

Fig. 91 : Corolla lower surface

Fig. 92 : Stem

Fig. 93 : Inflorescence axis



82,87,89	_____	} ALL 50 μ
83,88,93	_____	
84,85,90,91,92	_____	
86	_____	

Lindenbergia grandiflora

This species shows eleven types of trichomes
(Plate 14, Figs. 94-105).

1. Unicellular clavate

Foot : Simple. Body : 1-celled, erect, flexuous, distal part swollen, club-shaped; wall thin and smooth, but rugose at tip; lumen narrow except tip; content granulated, light yellowish (Fig. 94).

Distrib. : Corolla - lower surface.

2. Unicellular acerate

Foot : Simple. Body : Entire, acicular, erect (Fig. 95), or bent to one side from base (Fig. 96), tip sharply pointed; wall thick and smooth; lumen narrow; content translucent (Figs. 95 & 96).

Distrib. : Calyx, Corolla - lower surface, Anther filaments, Style, and Ovary.

3. Unicellular cylindrical

Foot : Simple. Body : Entire, erect, striated, tip rounded; wall thin and smooth; lumen wide; content yellowish or translucent (Fig. 97).

Distrib. : Corolla - lower surface and base of filament of Anthers.

4. Bicellular conical

Foot : Simple. Body : Entire, erect, upper cell long, narrowing to a pointed tip; lateral wall thick and smooth; lumen wide; content translucent (Fig. 98).

Distrib. : Petiole, Leaf - both surfaces and margin.

5. Bicellular cylindrical

Foot : Simple. Body : Entire, upper cell much longer than the lower one, tip pointed; wall thin and smooth; lumen wide; content translucent (Fig. 99).

Distrib. : Corolla - lower surface, and base of the filaments of Anthers.

6. Bicellular acuminate

Foot : Simple. Body : 2-celled, erect, upper cell long and narrow than the basal one, tip pointed; lateral wall thin or thick and smooth; lumen narrow; content translucent (Fig. 100).

Distrib. : Petiole, Leaf, and Calyx.

7. Uniseriate filiform

Foot : Simple. Body : Entire, 3-12 celled, filiform, cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 101).

Distrib. : Stem, Petiole, Leaf, and Corolla - lower surface.

8. Uniseriate acuminate

Foot : Simple. Body : Entire, 3-celled, cells long and narrow except basal cell, tip pointed; lateral wall thin and smooth; lumen narrow; content translucent (Fig. 102).

Distrib. : Stem, Leaf, Calyx, and Corolla - lower surface.

9. Uniseriate septate flagellate

Foot : Simple. Body : 3-celled, hyaline, flagellate, tip rounded; lateral and cross walls thin and smooth; lumen wide; narrow in distal cell; content translucent (Fig. 103).

Distrib. : Calyx and Corolla - lower surface.

10. Unicellular glandular capitate

Foot : Simple. Body : Differentiated, stalk short, 1-celled; head large, 4-celled, globular, cells arranged in one tier; outer wall thin and smooth; lumen wide; content dark, granulated (Fig. 104).

Distrib. : Leaf - upper surface.

11. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-6 celled, cells longer than broad except terminal short, collared cell; head small, globular, 1-celled, walls thin and smooth; lumen wide; content dark of head and collared cell, translucent of remaining stalk cells (Fig. 105).

Distrib. : Stem and Corolla - upper surface.

Lindenbergia macrostachya

This species shows seven types of trichomes
(Plate 14, Figs. 106-112).

1. Unicellular papillose

Foot : Simple. Body : Entire, short, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 106).

Distrib. : Corolla - margin.

2. Unicellular cylindrical

Foot : Simple. Body : Entire, straight, cylindrical, tip rounded; wall thick and smooth; lumen narrow; content translucent (Fig. 107).

Distrib. : Calyx - lower surface and Corolla.

3. Bicellular cylindrical

Foot : Simple. Body : Entire, erect, striated; cells longer than broad, base bulbous, tip rounded; lateral wall thin and smooth; lumen wide; content translucent (Fig. 108).

Distrib. : Bract.

4. Bicellular curved

Foot : Simple. Body : Entire, bent on one side at the septum, striated; upper cell longer than lower one; tip rounded; lateral wall thin and smooth; lumen wide;

content translucent (Fig. 109).

Distrib. : Bract.

5. Uniseriate filiform

Root : Simple. Body : Entire, erect, 3-6 celled, cells longer than broad, tip rounded; lateral and cross walls thin and smooth; lumen varying, content translucent (Fig. 110).

Distrib. : Inflorescence axis and Bract.

6. Peltate glandular

Root : Not visible. Body : 4-celled, Peltate, cells arranged parallel to epidermis, outer wall thin and smooth; content light granulated (Fig. 111).

Distrib. : Inflorescence axis.

7. Uniseriate glandular capitate

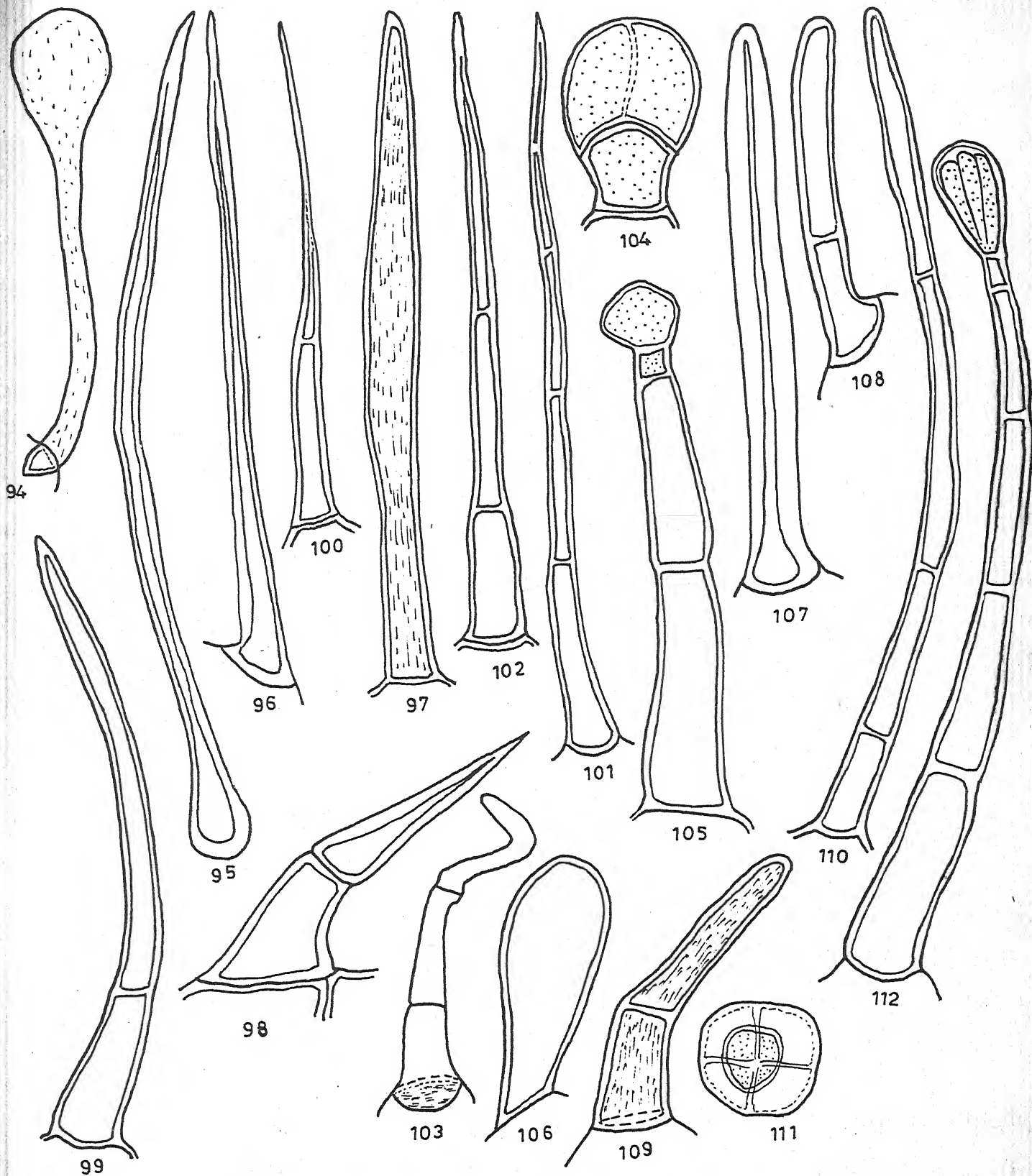
Root : Simple. Body : Differentiated; stalk very long, 3-6 celled; cells longer than broad, except short terminal collared cell; head oval, multicellular, cells elongated, arranged lengthwise in one tier; walls thin and smooth; cross walls thick; lumen wide; content granulated and translucent.

Distrib. : Inflorescence axis, Bract, Calyx, and Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 14

Trichomes from various plant parts

Figs. 94-105	:	<u>Lindenbergia grandiflora</u>
Fig. 94	:	Corolla lower surface
Fig. 95	:	Calyx upper "
Fig. 96	:	Ovary
Fig. 97	:	Anther filament
Fig. 98	:	Leaf margin
Fig. 99	:	Corolla lower surface
Fig. 100	:	Leaf upper "
Fig. 101	:	Petiole
Fig. 102	:	Stem
Fig. 103	:	Corolla lower surface
Fig. 104	:	Leaf upper "
Fig. 105	:	Stem
Figs. 106-112	:	<u>Lindenbergia macrostachya</u>
Fig. 106	:	Corolla margin
Fig. 107	:	Calyx
Fig. 108	:	Bract
Fig. 109	:	Bract
Fig. 110	:	Inflorescence axis
Fig. 111	:	Inflorescence axis
Fig. 112	:	Bract



94, 96, 97, 98, 102, 103, 105, 107

95, 99, 101, 108, 110, 112

100, 106, 111

104

109

ALL 50μ

Lindenbergia indica

This species shows eleven types of trichomes
(Plate 15, Figs. 113-123).

1. Unicellular clavate

Foot : Not visible. Body : Entire, long, narrow, swollen at the tip, club-shaped; wall thin and rugose; lumen narrow except tip; content light granulated evanescent (Fig. 113).
Distrib. : Corolla - lower surface.

2. Unicellular flagellate

Foot : Simple. Body : 1-celled, long, hyaline, fleshy, tip pointed; wall thin and smooth; lumen varying in breadth, content translucent (Fig. 114).

Distrib. : Anthers - base of the filament.

3. Unicellular acuminate

Foot : Simple. Body : Entire, long, acuminate, tip pointed; wall thick and smooth; lumen narrow; content evanescent (Fig. 115).

Distrib. : Calyx, Style - base and Ovary.

4. Bicellular curved

Foot : Simple. Body : Entire, long, curved at the septum, upper cell longer and narrower than basal one, tip rounded;

lateral wall thin, smooth and constricted at joints; cross wall thick; lumen wide; content translucent (Fig. 116).

Distrib. : Style and Ovary.

5. Bicellular asperate flagellate

Foot : Simple. Body : 2-celled, Differentiated; basal cell short, erect, and broad, upper cell very long, narrow and flagellate, tip pointed; lateral wall thin or thick and smooth; cross wall thick; content translucent (Fig. 117).

Distrib. : Petiole, Anthers - base of the filaments, and Ovary.

6. Uniseriate filiform

Foot : Simple. Body : Entire, 3-12 celled, filiform, cells longer than broad except basal one, tip rounded; lateral wall thin and smooth; cross walls thin; lumen narrow; content translucent (Fig. 118).

Distrib. : Stem, Petiole, Leaf - lower surface, Bract, Calyx, Corolla, and Ovary.

7. Uniseriate conical

Foot : Simple. Body : Entire, 3-5 celled, long, conical; lower cell much broader than the upper cells, tip pointed; lateral wall thick and smooth, cross walls thick; lumen wide; content translucent (Fig. 119).

Distrib. : Leaf.

8. Uniseriate septate flagellate

Foot : Simple. Body : Entire, very long, 8-12 celled, flexuous, cells longer than broad, tip rounded; lateral and cross walls thin and smooth; lumen varying; content evanescent, translucent (Fig. 120).

Distrib. : Stem, Petiole, Leaf - upper surface, Bract, Calyx and Anther filaments.

9. Uniseriate furcate

Foot : Simple. Body : Differentiated into long, unicellular axis and long multicellular lateral branch; cells long and narrow, tips pointed; lateral and cross walls thin and smooth; content translucent (Fig. 121).

Distrib. : Corolla - upper surface.

10. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, cell rectangular; head multicellular, oval and large; cells elongated, arranged lengthwise in one tier; tip papillate, outer wall thin and smooth; lumen wide; content dark granulated of head, and translucent of stalk cells (Fig. 122).

Distrib. : Petiole.

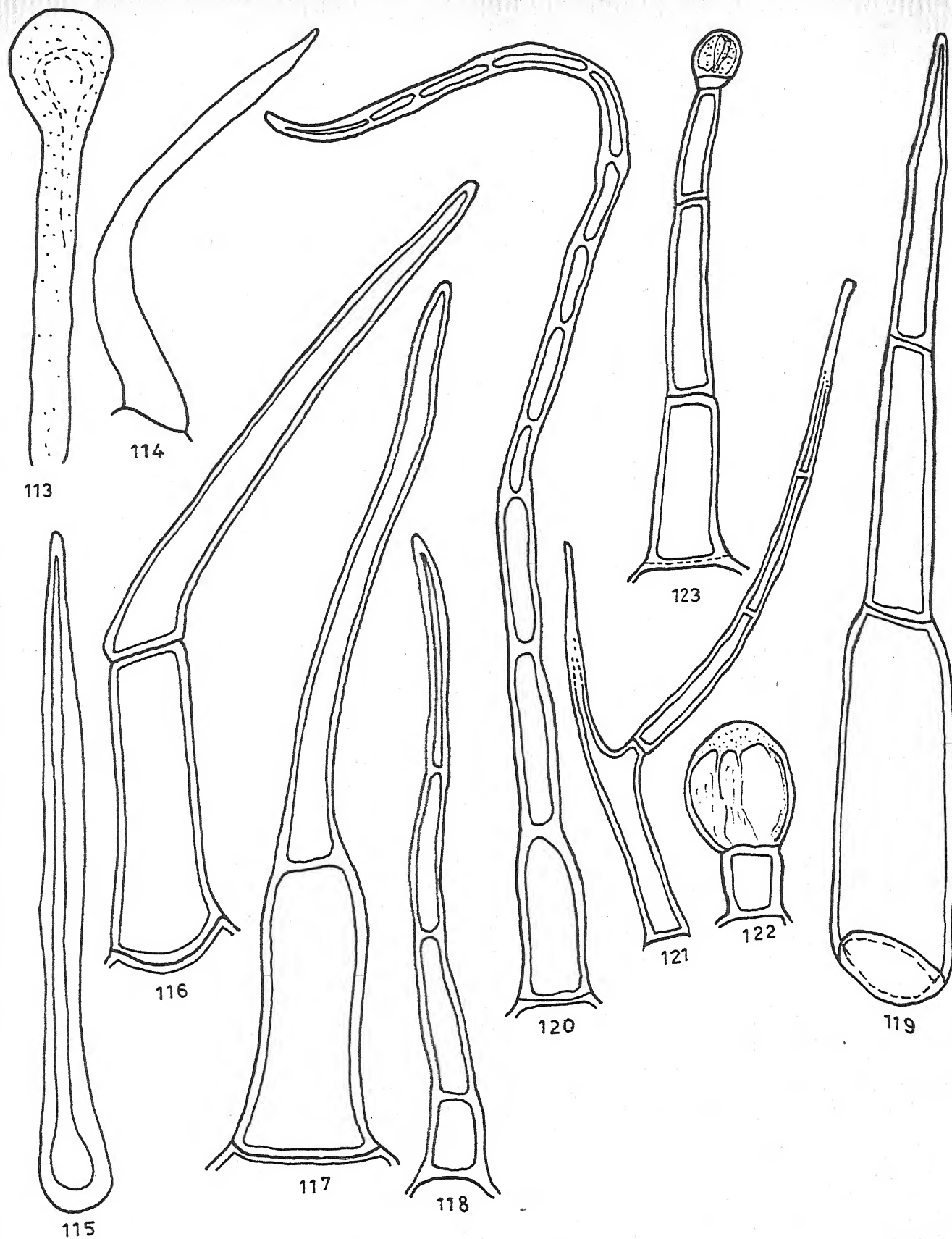
11. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated, stalk long, 3-7 celled,

EXPLANATION OF THE FIGURES OF PLATE - 15

Trichomes from various plant parts

- Figs. 113-123 : Lindenbergia indica
Fig. 113 : Corolla lower surface
Fig. 114 : Anther filament
Fig. 115 : Calyx
Fig. 116 : Ovary
Fig. 117 : Petiole
Fig. 118 : Stem
Fig. 119 : Leaf
Fig. 120 : Petiole
Fig. 121 : Corolla upper surface
Figs. 122, 123 : Petiole



113, 114, 115, 118 _____
 116, 117, 122 _____
 119, 120, 121, 123 _____

ALL 50 μ

cells longer than broad, except short terminal collared cell; head globular, multicellular, cells elongated and arranged in one tier; outer and cross walls thin and smooth; lumen wide; content translucent (Fig. 123).

Distrib. : Stem, Petiole, Leaf, Bract, Pedicel, Calyx, Corolla and Anther filaments.

Lindenbergia muraria

This species shows seven types of trichomes (Plate 16, Figs. 124-130).

1. Unicellular clavate

Foot : Simple. Body : Entire, long, narrow, flexuous, tip swollen, club-shaped; wall thin and rugose; lumen narrow, but wide at distal end; content light granulated (Fig. 124).

Distrib. : Corolla - lower surface.

2. Unicellular acerate

Foot : Simple. Body : long, narrow, needle like, tip pointed; wall thick and smooth; lumen narrow; content evanescent (fig. 125).

Distrib. : Pedicel and Calyx.

3. Bicellular conical

Foot : Simple. Body : Entire, long, conical; cells long, tip pointed; lateral wall thick and smooth; cross wall

thin; lumen wide; content translucent (Fig. 126).

Distrib. : Leaf - upper surface & margin and Calyx.

4. Uniseriate filiform

Foot : Simple. Body : Entire, long, 3-6 celled; cells longer than broad, tip rounded; lateral wall thin and smooth; cross walls thin; lumen wide; content translucent (Fig. 127).

Distrib. : Stem, Petiole, Leaf, Pedicel, Bract, Calyx and Corolla.

5. Uniseriate aseptate flagellate

Foot : Simple. Body : Entire, long, 3-celled, terminal cell very long, narrow and flexuous, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content opaque (Fig. 128).

Distrib. : Calyx - lower surface.

6. Uniseriate furcate

Foot : Simple. Body : Differentiated, branched; main axis 2-celled, basal cell bulbous, erect, upper cell long, narrow, furcate with 2-cell long lateral branch; cells longer than broad, tips rounded; lateral wall thin and smooth; cross walls thick; content translucent (Fig. 129).

Distrib. : Petiole.

7. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk very long, 3-8 celled; cells longer than broad, except terminal short collared cell; head, oval, multicellular, cells long, arranged in one tier, tip papillate; walls thin and smooth; content granulated dark of head and collared cell, translucent of stalk cells (Fig. 130).

Distrib. : Stem, Petiole, Leaf, Pedicel, Calyx, and Corolla - upper surface.

Adenoma capitatum

This species shows eight types of trichomes (Plate 16, Figs. 131-138).

1. Unicellular flagellate

Foot : Simple. Body : 1-celled, long, flagellate, tip rounded; wall thin and smooth; lumen narrow; content translucent (Fig. 131).

Distrib. : Corolla - lower surface.

2. Bicellular curved

Foot : Simple. Body : Entire, curved, at septum, upper cell long and narrow, tip pointed; lateral wall thin and smooth; lumen narrow; content translucent (Fig. 132).

Distrib. : Calyx - lower surface.

3. Uniseriate filiform

Foot : Simple. Body : Entire, 3-6 celled, filiform, cells longer than broad, tip rounded; lateral wall thin and smooth; cross walls thick; lumen wide; content translucent (Fig. 133).

Distrib. : Stem and Leaf apex.

4. Uniseriate conical

Foot : Simple. Body : Entire, 3-6 celled, conical, erect, or bent on one side from base; tip pointed; lateral and cross walls thick and smooth; lumen narrow; content translucent (Fig. 134).

Distrib. : Leaf.

5. Uniseriate cylindrical

Foot : Compound. Body : Entire, 3-celled, cylindrical; cells longer than broad, tip rounded; lateral wall thick, smooth and constricted at joints; cross walls thin; lumen wide; content translucent (Fig. 135).

Distrib. : Bract.

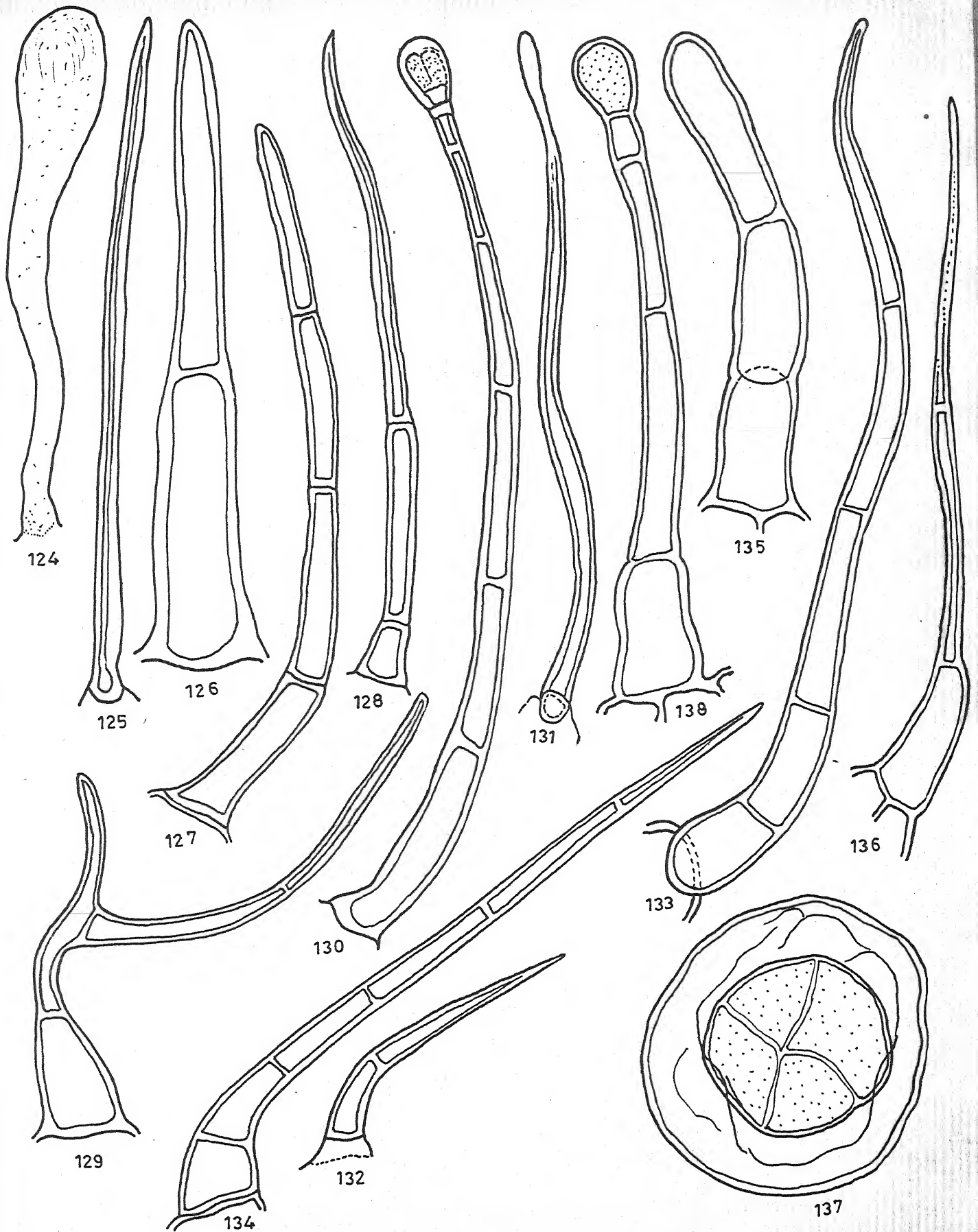
6. Uniseriate septate flagellate

Foot : Compound. Body : Differentiated, long, 3-5 celled; basal cell pulvinus, upper cell very long, narrow and flexuous, tip pointed; lateral and cross walls thin and smooth; lumen narrow except the basal cell; content

EXPLANATION OF THE FIGURES OF PLATE - 16

Trichomes from various plant parts

- Figs. 124-130 : Lindenbergia muraria
Fig. 124 : Corolla lower surface
Fig. 125 : Calyx upper "
Fig. 126 : Leaf upper "
Fig. 127 : Stem
Fig. 128 : Calyx lower surface
Fig. 129 : Petiole
Fig. 130 : Stem
- Figs. 131-138 : Adenosma capitatum
Fig. 131 : Corolla lower surface
Fig. 132 : Calyx lower "
Fig. 133 : Stem
Fig. 134 : Leaf lower surface
Fig. 135 : Bracteole
Fig. 136 : Calyx margin
Fig. 137 : Calyx upper surface
Fig. 138 : Bracteole



124, 126, 137	_____	} ALL 50 μ
125, 127, 128, 129, 130, 131, 135	_____	
132, 138	_____	
133, 134, 136	_____	

translucent (Fig. 136).

Distrib. : Bract, Calyx - upper surface, and margin.

7. peltate glandular vesicular

Foot : Not visible. Body : Peltate, sessile, multicellular disc, parallel to epidermis; outer wall thin, smooth and highly vesiculate; content granulated light yellowish (Fig. 137).

Distrib. : Stem, Leaf, and Calyx - upper surface.

8. Uniseriate glandular capitate

Foot : Compound. Body : Differentiated; stalk, long, 3-6 celled, cells of varying size and shape, terminal cell short collared; head rounded, 1-celled, outer, lateral and cross walls thin and smooth; lumen wide; content dark granulated of head and collared cells, translucent that of remaining stalk (Fig. 138).

Distrib. : Bract.

Stemodia viscosa

This species shows six types of trichomes (Plate 17, Figs. 139-146).

1. Unicellular flagellate

Foot : Not visible. Body : Entire, long, hyaline, flagellate, tip rounded; wall thin and smooth; lumen wide; content

translucent (Fig. 139).

Distrib. : Corolla - lower surface.

2. Unicellular conical

Foot : Simple. Body : Entire, conical, tip rounded; wall thin and rugose; content translucent (Fig. 140).

Distrib. : Anthers - base of the filament.

3. Peltate glandular

Foot : Not visible, except marking. Body : Peltate, multicellular, 1-celled thick shield-like disc, parallel to epidermis; cells radiate from common center; outer wall thick and wavy; radial wall thin; content light granulated (Fig. 141).

Distrib. : Stem.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled head globular, large, 1-celled; wall thin and smooth; lumen wide; content granulated, translucent (Fig. 142).

Distrib. : Stem and Leaf - upper surface.

5. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled long, cells longer than broad; head large, 2-4 celled, cells

arranged in one tier; outer and lateral walls thin and smooth; lumen wide; content of head granulated and translucent (Fig. 143).

Distrib. : Leaf - upper surface, Pedicel, and Calyx.

6. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-9 celled, cells longer than broad; head globular, 1 many celled; walls thin or thick, smooth; cross walls thin; lumen narrow or wide; content dark yellowish of head, and translucent that of stalk cells (Figs. 144, 145 & 146).

Distrib. : Stem, Leaf, Bractiole, Pedicel, Calyx, Corolla, and Ovary.

Stemodia sufruticosa

This species shows five types of trichomes (Plate 17, Figs. 147-153).

1. Uniseriate filiform

Foot : Compound. Body : Entire, long, 6-11 celled, cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 147).

Distrib. : Stem, Leaf, Pedicel, and Calyx - upper surface.

2. Uniseriate septate flagellate

Foot : Compound. Body : Entire, 4-6 celled long, flagellate, cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen narrow, content translucent (Fig. 148).

Distrib. : Stem, Leaf, and Calyx - lower surface.

3. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, longer than broad; head rounded, large, multicellular, elongated cells directly seated on stalk cell; outer wall thin and smooth; lumen wide; content granulated translucent (Fig. 149).

Distrib. : Stem, Leaf - upper surface, and Pedicel.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, cells equal in size and rectangular (Fig. 150), or lower cell much longer and broader than upper short collared cell (Fig. 151); head 1-celled, globular, inflated, densely filled with starch grains (Fig. 151) or 4-celled, devoid of starch grains; outer wall thin and smooth; content granulated dark or translucent (Figs. 150 & 151).

Distrib. : Stem, Leaf - upper surface along mid-rib, lower surfaces of Calyx, and Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 17

Trichomes from various plant parts

Figs. 139-146 : Stemodia viscosa

Fig. 139 : Corolla lower surface

Fig. 140 : Anther filament

Fig. 141 : Stem

Fig. 142 : Leaf upper surface

Fig. 143 : Calyx upper "

Figs. 144, 145 : Stem

Fig. 146 : Bracteole

Figs. 147-153 : Stemodia subfruticosa

Fig. 147 : Stem

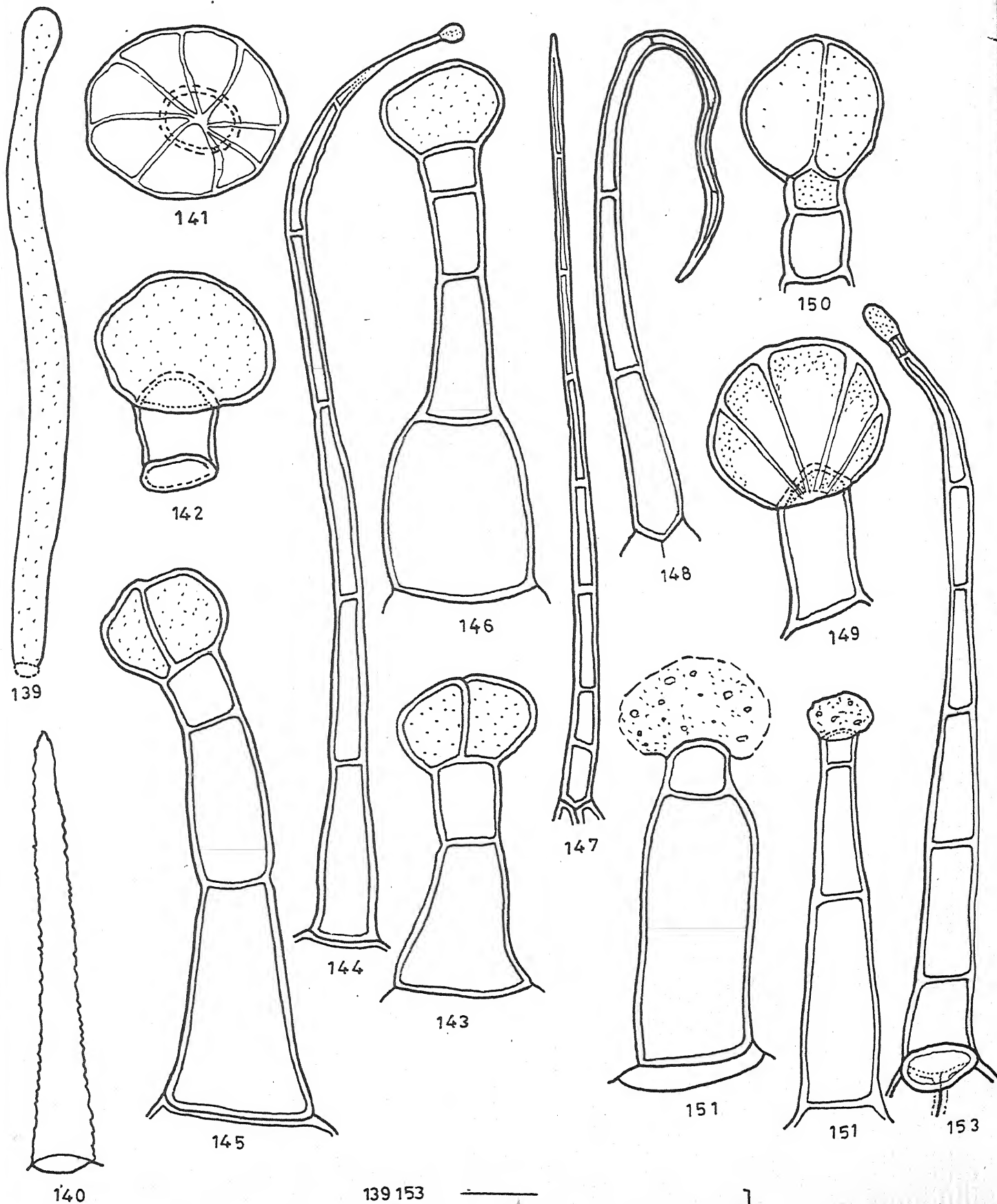
Fig. 148 : Leaf upper surface

Figs. 149, 150 : Stem

Fig. 151 : Leaf upper surface

Fig. 152 : Stem

Fig. 153 : Calyx lower surface



139 153
 140, 152
 141
 142, 143, 145, 146, 148, 149, 150, 151
 144
 147

ALL 50μ

5. Uniseriate glandular capitate

Foot : Simple. **Body :** Differentiated; stalk long, 3-8 celled, cells longer than broad, except short collared cells; head globular, 1-celled, inflated, filled with starch grains (Fig. 152) or oval, devoid of starch grains (Fig. 153), outer wall thin, smooth hyaline; lateral and cross walls thick; content dense of collared cell and translucent of head and other stalk cells (Fig. 152 & 153).
Distrib. : Stem, Leaf - upper surface along mid-rib, Pedicel, Calyx, and Corolla.

Limnophila sessiliflora

This species shows four types of trichomes
 (Plate 18, Figs. 154-157).

1. Unicellular clavate

Foot : Not visible. **Body :** Entire, very long, tubular, distal part swollen, club-shaped; wall thin and rugose; lumen narrow except the tip; content translucent (Fig. 154).

Distrib. : Corolla - lower surface, at the point of attachment of Anther filament.

2. Unicellular conical

Foot : Compound. **Body :** Entire, short, conical, tip pointed;

wall thick and smooth; lumen wide; content translucent (Fig. 155).

Distrib. : Calyx tip.

3. Unicellular dentate

Foot : Compound. Body : Entire, stiff, erect, dentate, tip pointed; wall thick and smooth; lumen varying, content evanescent translucent (Fig. 156).

Distrib. : Leaf - apex, and Bract.

4. Peltate glandular vesicular

Foot : Not visible. Body : Peltate, 4-celled disc, 1-celled in thickness, parallel to epidermis; cells large and cruciately arranged; outer wall thin and reveals many hyaline infoldings; content translucent (Fig. 157).

Distrib. : Stem, Leaf, Bract, Calyx, and Corolla.

Limnophila gratioloides

This species shows four types of trichomes (Plate 18, Figs. 158-161).

1. Uniseriate conical

Foot : Simple. Body : Entire, 3-5 celled, conical, tip rounded; cells longer than broad, terminal cell much longer than others; lateral wall thick and smooth; cross walls thin;

lumen wide; content translucent (Fig. 158).

Distrib. : Calyx.

2. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 3-5 celled, flagellate, tip pointed; cells of various sizes and shapes; lateral wall thin, convex and smooth; cross walls thin; lumen wide; content translucent (Fig. 159).

Distrib. : Bracteole and Leaf - lower surface.

3. Peltate porous glandular

Foot : Not visible except markings. Body : Peltate, 4-celled, sessile, 1-celled thick disc; cells radiating from center, parallel to epidermis; outer wall thin and smooth; content light granulated (Fig. 160).

Distrib. : Stem and Leaf.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 2-celled, cells rectangular; head large, oval, 1-celled, outer and later walls thin and smooth; content translucent or granulated (Fig. 161).

Distrib. : Calyx - upper surface.

Limnophila chinensis

This species shows six types of trichomes
(Plate 18, Figs. 162-167).

1. Unicellular flagellate

Foot : Not visible. Body : 1-celled, large flagellate, tip rounded; lateral wall thin and verrucose; lumen varying; content dense, granulated (Fig. 162).

Distrib. : Corolla - lower surface at the point of attachment of Anther filaments.

2. Unicellular conical

Foot : Compound. Body : Entire, short, conical, tip pointed; lateral wall thick and smooth; lumen wide; content translucent (Fig. 163).

Distrib. : Leaf - toothed margin, Bract - tip and margin.

3. Uniseriate septate flagellate

Foot : Simple. Body : Beaded, 5-10 celled; cells longer than broad, tip pointed; lateral wall thin, convex and constricted at septum; cross walls thin; lumen wide; content translucent (Fig. 164).

Distrib. : Stem.

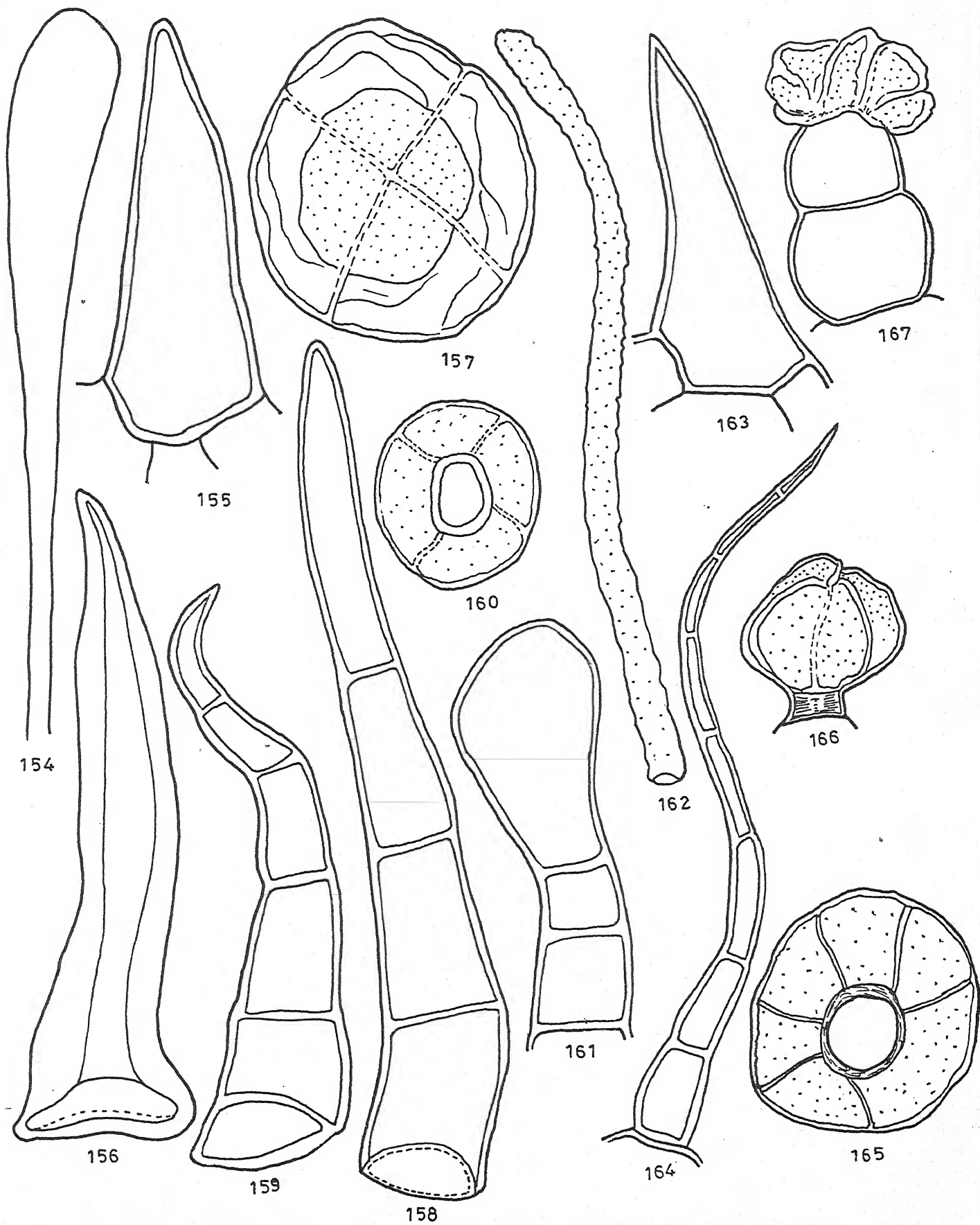
4. Feltate porous glandular

Foot : Not visible. Body : Multicellular, shield-like,

EXPLANATION OF THE FIGURES OF PLATE - 18

Trichomes from various plant parts

- Figs. 154-157 : Limnophila sessiliflora
Fig. 154 : Corolla lower surface
Fig. 155 : Calyx tips
Fig. 156 : Leaf
Fig. 157 : Stem
- Figs. 158-161 : Limnophila gratioloides
Fig. 158 : Calyx lower surface
Fig. 159 : Leaf lower "
Fig. 160 : Stem
Fig. 161 : Calyx upper surface
- Figs. 162-167 : Limnophila chinensis
Fig. 162 : Corolla lower surface
Fig. 163 : Leaf upper "
Figs. 164-166 : Stem
Fig. 167 : Calyx lower surface



154,159
155,156,157,161,165
158,160,163,166,167
162,164

ALL 50μ

circular in shape, parallel to epidermis; 1-celled thick, 6-8 cells in diameter, central part hollow; outer wall thin and smooth; content light granulated (Fig. 165).

Distrib. : Stem, Leaf, and Bract.

5. Unicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk much shorter, 1-celled; head large, globular, 4-celled, outer wall thin, smooth and vesiculate; content dense granulated (Fig. 166).

Distrib. : Stem.

6. Bicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk 2-celled, cells broader than long; head large, irregularly inflated, multicellular; cells of various shapes and sizes, inserted directly on the upper cell of stalk; outer wall thin, prominently constricted at the cross walls, vesiculate; content dense, of head, and translucent that of stalk cells (Fig. 167).

Distrib. : Calyx - lower surface and margin, and Pedicel.

Limnophila indica

This species shows five types of trichomes (Plate 19, Figs. 168-172).

1. Unicellular flagellate

Foot : Simple. Body : Entire, long, hyaline, flagellate.

distal end spoon-shaped, tip rounded; wall thin and smooth; lumen wide; content light granulated (Fig. 168).

Distrib. : Corolla - upper surface.

2. Unicellular dentate

Foot : Compound. Body : Entire, short, dentate, tip pointed; wall thick and smooth; content translucent (Fig. 169).

Distrib. : Leaf - margin.

3. Bicellular filiform

Foot : Simple. Body : Entire, long, filiform, upper cell longer than the lower one, tip rounded; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 170).

4. Uniseriate hooked

Foot : Compound. Body : Entire, long 4-6 celled, hooked, cells except basal one longer than broad, tip pointed; lateral and cross walls thick and smooth; lumen wide; content translucent (Fig. 171).

Distrib. : Calyx - lower surface and margin.

5. Peltate glandular vesicular

Foot : Not visible. Body : Peltate, 4-celled, sessile, 1-cell thick, disc, parallel to epidermis, cells radiating

from center; outer wall thin and smooth, cuticular vesicle enclosing the body, reveals various infoldings; content granulated dense (Fig. 172).

Distrib. : Leaf and Calyx.

Bacopa monnieri

This species shows three types of trichomes (Plate 19, Figs. 173-175).

1. Uniseriate cylindrical

Foot : Simple. Body : Entire, short 3-celled, cylindrical, tip rounded or truncate; lateral wall thick and smooth; lumen wide; content evanescent translucent (Fig. 173).

Distrib. : Calyx - upper surface and Corolla.

2. Uniseriate septate flagellate

Foot : Simple. Body : 3-celled, flagellate, tip pointed; lateral and cross wall thin and smooth; lumen wide; content translucent (Fig. 174).

Distrib. : Corolla - lower surface.

3. Peltate glandular

Foot : Not visible. Body : Peltate, multicellular, 1-cell thick sessile disc, parallel to epidermis; cells radiate from center; outer wall thin and smooth; radial wall thick; content dense granulated (Fig. 175).

Distrib. : Stem, Leaf, Bracteole, and Calyx.

EXPLANATION OF THE FIGURES OF PLATE - 19

Trichomes from various plant parts

Figs. 168-172 : Limnophila indica

Fig. 168 : Corolla upper surface

Fig. 169 : Leaf margin

Fig. 170 : Stem

Fig. 171 : Calyx margin

Fig. 172 : Leaf upper surface

Figs. 173-175 : Bacopa monnieri

Fig. 173 : Calyx upper surface

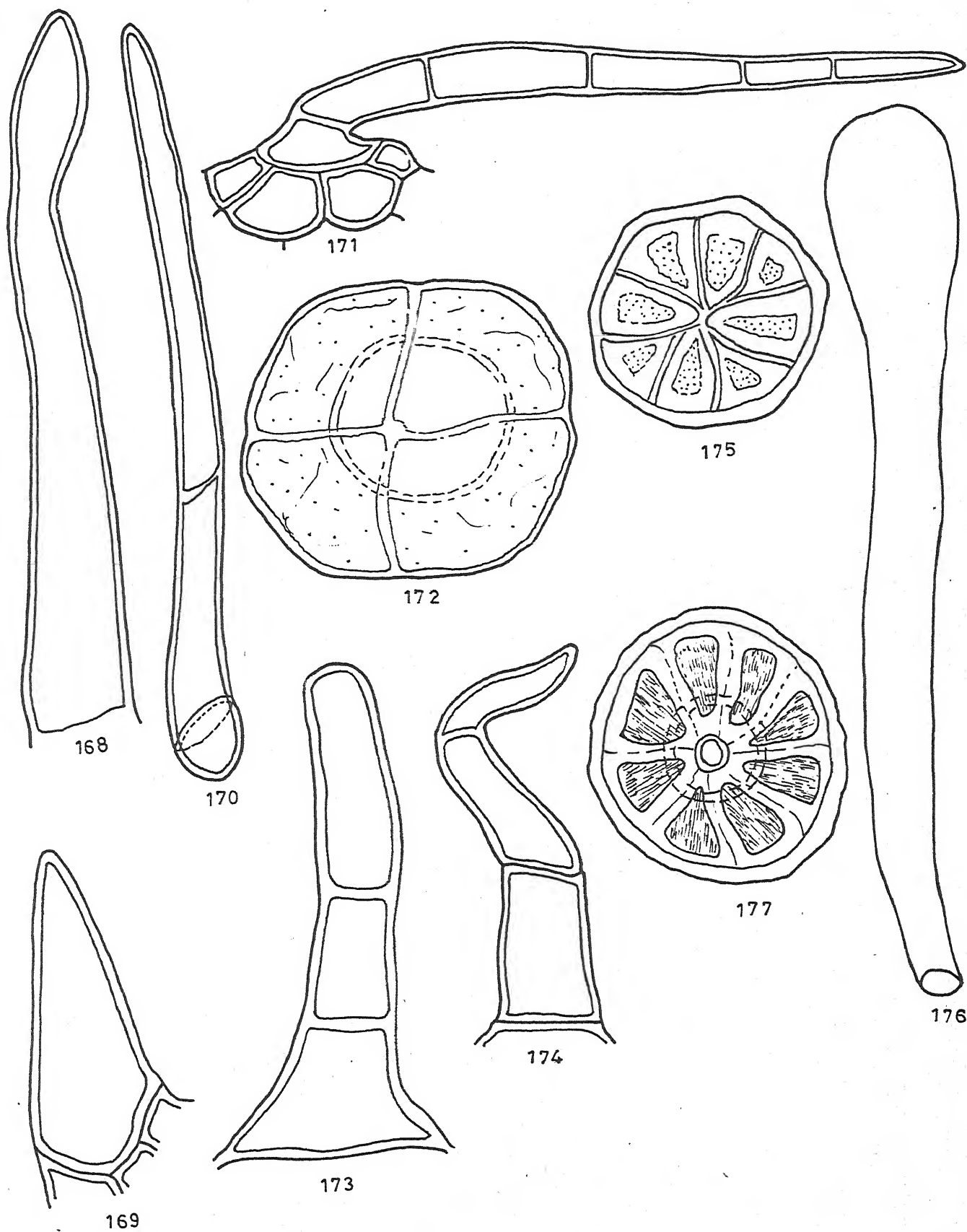
Fig. 174 : Corolla lower "

Fig. 175 : Leaf upper "

Figs. 176-177 : Bacopa procumbens

Fig. 176 : Corolla lower surface

Fig. 177 : Stem



168, 169, 174	_____] ALL 50 μ
170, 171, 176	_____	
172, 173, 175, 177	_____	

Bacopa procumbens

This species shows two types of trichomes
(Plate 19, Figs. 176 & 177).

1. Unicellular clavate

Foot : Not visible. Body : 1-celled, long, hyaline, flagellate, tubular, tip swollen, club-shaped; wall thin and rugose; lumen wide; content translucent (Fig. 176).

2. Peltate porous glandular

Foot : Not visible except marking. Body : Peltate, multicellular, sessile, 1-celled thick, parallel to epidermis; cells radiating from center; outer wall thin, smooth and vesiculate, radial wall hyaline; content granulated dark (Fig. 177).

Distrib. : Stem, Leaf, Bract, and Calyx.

Gratiola officinalis

This species shows four types of trichomes
(Plate 20, Figs. 178-181).

1. Unicellular clavate

Foot : Not visible. Body : Entire, long tubular, striated, flagellate, tip swollen; club-shaped; wall thin and rugose; lumen narrow except tip; content light granulated (Fig. 178).

Distrib. : Corolla - lower surface.

2. Peltate porous glandular

Foot : Sunken, not visible. Body : Peltate, multicellular, shield-like, sessile, 1-cell thick disc, parallel to epidermis; cells radiating from porous center; central part hollow; outer wall thin and smooth; radial wall thin and hyaline; content light granulated (Fig. 179).

Distrib. : Stem, leaf lower - surface, Bracteole, Pedicel, and Calyx.

3. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk very short, 1-celled; head 1-celled, larger, much inflated, ovoid, outer wall thin, entire, and smooth, revealing many infoldings; lumen wide; content translucent of head, dark that of stalk (Fig. 180).

Distrib. : Calyx.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk very short, 2-celled, bent, cells longer than broad; head small, hyaline, globular, 1-celled; outer and lateral wall thin and smooth; content dense of upper stalk cell, translucent that of head and lower stalk cell (Fig. 181).

Distrib. : Calyx - margin.

Popatrium linceum

This species shows two types of trichomes
(Plate 20, Figs. 182-183).

1. Unicellular cylindrical

Foot : Simple. Body : Hyaline, short, cylindrical, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 182).

Distrib. : Corolla - lower surface, and Anthers - base of the filament.

2. Peltate porous glandular

Foot : Not visible. Body : Peltate, multicellular, sessile disc, parallel to epidermis, cells arranged around the hollow centre; outer wall thin and smooth; content yellowish granulated (Fig. 183).

Distrib. : Leaf - lower surface.

Artanema angustifolium

This species shows five types of trichomes
(Plate 20, Figs. 184-188).

1. Unicellular papillose

Foot : Not visible. Body : Entire, erect, striated, tip pointed; wall thin and smooth; lumen wide; content opaque (Fig. 184).

Distrib. : Corolla - upper surface.

2. Unicellular dentate

Foot : Simple or compound. Body : Entire, dentate, tip pointed; wall thick and verrucose; lumen wide; content opaque (Fig. 185).

Distrib. : Stem, Leaf - margin, Pedicel, Calyx - upper surface.

3. Peltate porous glandular

Foot : Not visible, except marking. Body : Peltate, multicellular, sessile, 1-cell thick disc, parallel to epidermis; cells arranged around, large hollow center; outer wall thin, convex and constricted at joints; content granulated (Fig. 186).

Distrib. : Stem, Leaf, lower surface, Calyx and Corolla - upper surface.

4. Bicellular glandular capitate

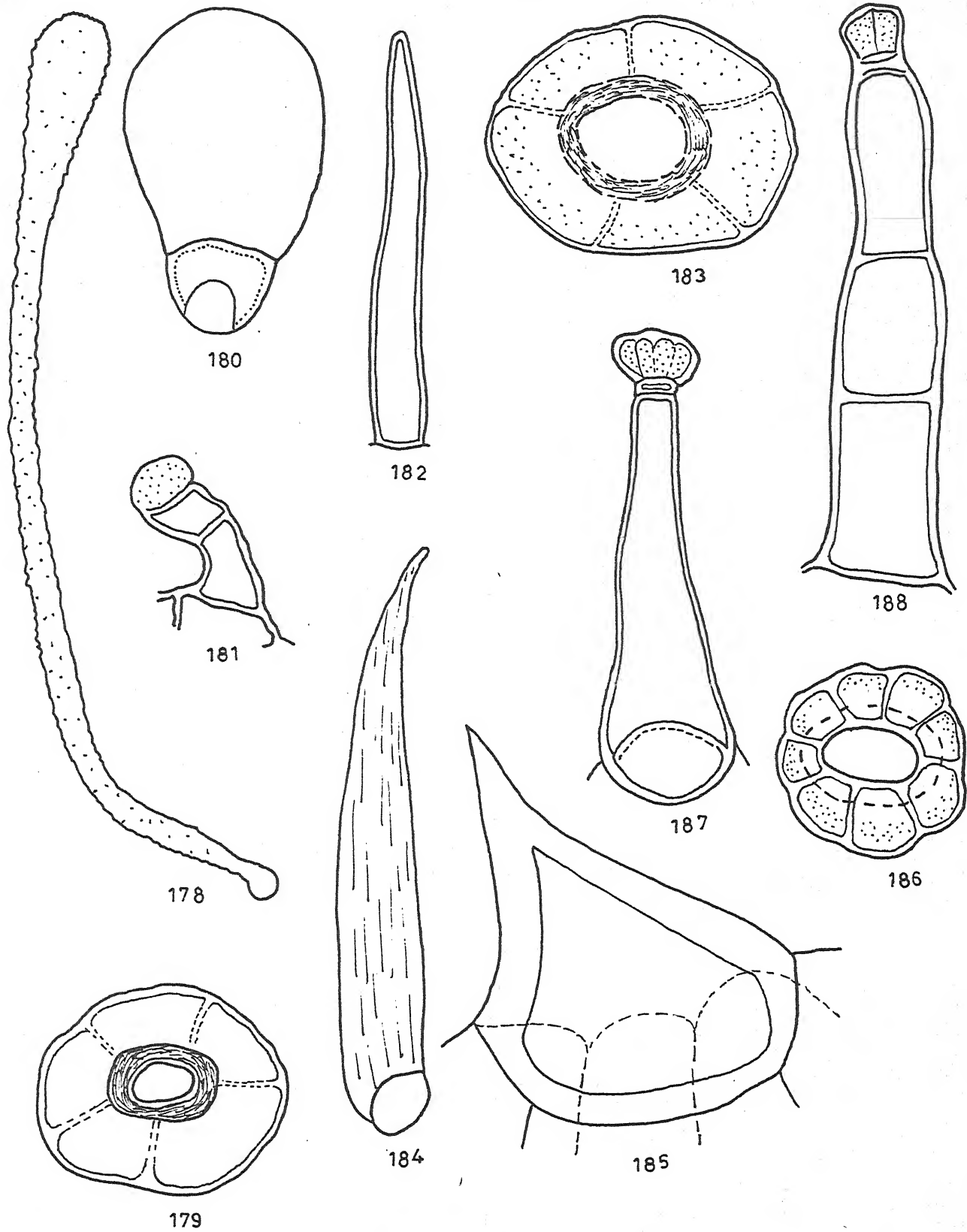
Foot : Simple. Body : Differentiated; stalk long 2-celled, lower cell much longer than upper short collared cell; head inflated, multicellular, a number of elongated glandular cells directly on the short terminal cell of the stalk; outer and lateral walls thin and smooth; content dark of head and collared cell, translucent that of stalk (Fig. 187).

Distrib. : Corolla - upper surface.

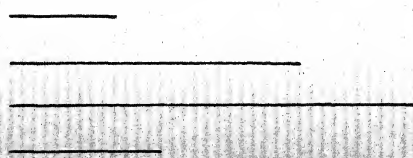
EXPLANATION OF THE FIGURES OF PLATE - 20

Trichomes from various plant parts

- Figs. 178-181 : Gratiola officinalis
Fig. 178 : Corolla lower surface
Fig. 179 : Leaf upper "
Fig. 180 : Calyx upper "
Fig. 181 : Calyx margin
- Figs. 182-183 : Dopatrium junceum
Fig. 182 : Corolla lower surface
Fig. 183 : Leaf lower
- Figs. 184-188 : Artanema angustifolium
Fig. 184 : Corolla upper surface
Fig. 185 : Leaf margin
Fig. 186 : Stem
Fig. 187 : Corolla upper surface
Fig. 188 : Corolla lower "



178, 182
179, 185
180, 181, 183, 186
184, 187, 188



ALL 50 μ

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, hyaline, thin multicellular cells; cells longer than broad, terminal cell much shorter, collared ; head small, beaked, 4-celled, outer and lateral walls thin and smooth; cross walls thin; lumen of stalk cells wide; content dense of head and collared cell, translucent that of stalk cells (Fig. 188).
Distrib. : Corolla - lower surface.

Craterostigma plantigenia

This species shows six types of trichomes
(Plate 21, Figs. 189-194).

1. Unicellular papillose

Foot : Compound. Body : Entire, short, papillose, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 189).
Distrib. : Corolla - margin.

2. Unicellular clavate

Foot : Simple. Body : Entire, straight, narrow below with swollen bulbous head; wall thin and smooth; lumen wide; content light, granulated (Fig. 190).
Distrib. : Corolla.

3. Unicellular flagellate

Foot : Simple. Body : Entire, flagellate, tapering towards tip; wall thin and rugose; content translucent (Fig. 191).

Distrib. : Calyx - tips, and Bract.

4. Unicellular acuminate

Foot : Simple. Body : Entire, straight, tapering to acute tip; wall thick and smooth; lumen narrow; content translucent (Fig. 192).

Distrib. : Petiole and Calyx.

5. Unicellular conical

Foot : Simple or compound. Body : Entire, erect, conical, tip pointed; wall thin and rugose; lumen wide; narrowing above; content translucent (Fig. 193).

Distrib. : Petiole, Leaf, Inflorescence axis, Bract and Calyx - upper surface.

6. Unicellular cylindrical

Foot : Simple. Body : Entire, straight, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 194).

Distrib. : Leaf, Bract, Inflorescence axis, Calyx - upper surface and stigma.

Craterostigma purilum

This species shows eight types of trichomes
(Plate 21, Figs. 195-202).

1. Unicellular papillose

Foot : Simple. Body : Entire, club-shaped, bluntly rounded tip; wall thin and rugose; lumen wide; content translucent (Fig. 195).

Distrib. : Stigma.

2. Unicellular clavate

Foot : Simple. Body : Entire, clavate, tip swollen; wall thin and smooth; lumen wide; content translucent (Fig. 196).

Distrib. : Corolla - lower surface.

3. Unicellular flagellate

Foot : Simple. Body : Entire, distal part flagellate, tip pointed; wall thin and rugose; lumen narrow; content translucent (Fig. 197).

Distrib. : Inflorescence axis.

4. Unicellular hooked

Foot : Compound. Body : Entire, distal end curved to become horizontal; wall thin and rugose; lumen wide, content translucent (Fig. 198).

Distrib. : Bract - lower surface.

5. Unicellular curved

Foot : Simple. Body : Entire, falcate, tip pointed; wall thin and rugose; lumen wide; content translucent (Fig. 199).
Distrib. : Leaf, Inflorescence axis, Bract, and Calyx.

6. Unicellular dentate

Foot : Compound. Body : Entire, dentate, tip pointed; wall thick and rugose; lumen narrow; content translucent (Fig. 200).

Distrib. : Leaf - margin.

7. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short, broader than longer; head globular, 1-celled, with infoldings; outer wall thin and smooth; lumen wide; content translucent (Fig. 201).

Distrib. : Corolla - upper surface.

8. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-4 celled; cells longer than broad; lateral walls thin, smooth and uneven; head large, globular, multicellular, cells varying in shape and size, arranged irregularly; outer wall thin and uneven; content of head dense, translucent that of stalk (Fig. 202).

Distrib. : Corolla - upper surface.

EXPLANATION OF THE FIGURES OF PLATE - 21

Trichomes from various plant parts

Figs. 189-194 : Craterostigma plantaginea

Figs. 189, 190 : Corolla margin

Fig. 191 : Calyx upper surface

Fig. 192 : Petiole

Fig. 193 : Inflorescence axis

Fig. 194 : Leaf upper surface

Figs. 195-202 : Craterostigma punctatum

Fig. 195 : stigma

Fig. 196 : Corolla lower surface

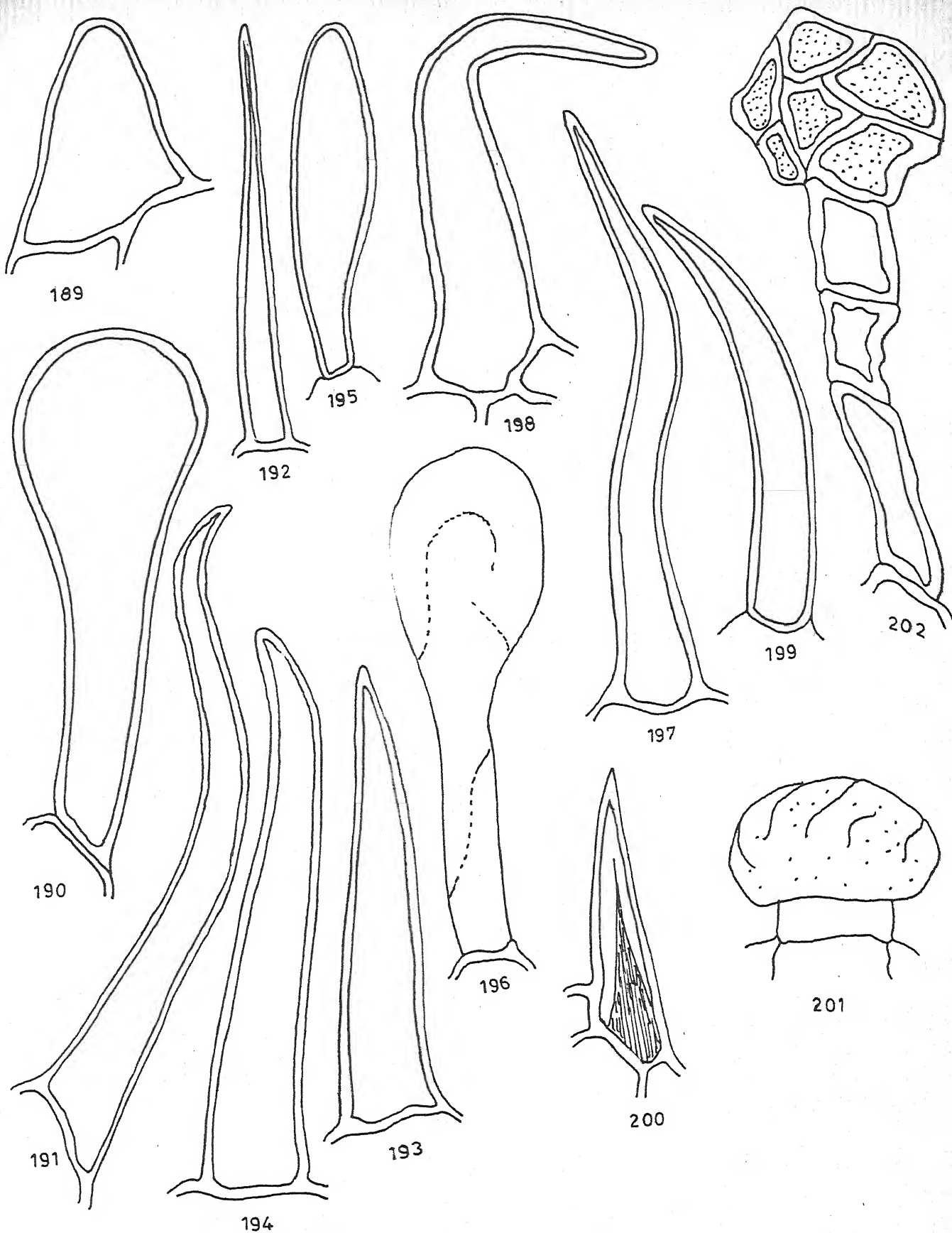
Fig. 197 : Inflorescence axis

Fig. 198 : Bract

Fig. 199 : Calyx upper surface

Fig. 200 : Leaf margin

Figs. 201, 202 : Corolla upper surface



189, 190, 195, 196, 198, 201, 202
191, 192, 193, 194, 197, 199, 200

ALL 50 μ

Torenia cordifolia

This species shows eight types of trichomes
(Plate 22, Figs. 203-210).

1. Unicellular hooked

Foot : Simple. Body : 1-celled, short, distal part curved sharply, tip pointed; wall thick and rugose; lumen wide; content opaque (Fig. 203).

Distrib. : Leaf margin.

2. Unicellular curved

Foot : Simple. Body : 1-celled, hyaline, bent on one side, tip pointed; wall thin and smooth; lumen wide; content translucent (Fig. 204).

Distrib. : Petiole.

3. Unicellular dentate

Foot : Simple. Body : Entire, erect, tip pointed; wall thick and smooth; lumen wide; content translucent (Fig. 205).

Distrib. : Leaf margin.

4. Bicellular conical

Foot : Simple. Body : Entire, upper cell longer and narrower than basal short cell, tip pointed; lateral wall thin and rugose, lumen wide; content translucent (Fig. 206).

Distrib. : Calyx - upper surface and margin.

5. Uniseriate conical

Foot : Simple. Body : Entire, 3-5 celled, terminal cell longer than others, tip pointed; lateral wall convex, thick and rugose; cross walls thick; lumen wide; content translucent (Fig. 207).

Distrib. : Stem, Petiole, Leaf, Pedicel, and Calyx.

6. Uniseriate hooked

Foot : Simple. Body : Entire, 3-celled, erect, terminal cell barbed, tip pointed; lateral wall thin and rugose; lumen wide; content translucent (Fig. 208).

Distrib. : Stem, Leaf - upper surface, and Pedicel.

7. Peltate glandular

Foot : Not visible. Body : Peltate, 4-celled, sessile, 1-cell thick disc, parallel to epidermis; cells opposite to each other; outer wall thin, convex and smooth; content granulated translucent (Fig. 209).

Distrib. : Stem, Petiole, Leaf, Pedicel, Calyx and Corolla - upper surface.

8. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk very short 1-celled; head large, inflated, 4-celled; cells arranged in one tier; outer wall thin and smooth; lumen wide; content

granulated translucent (Fig. 210).

Distrib. : Anther filaments.

Torenia fourneiri

This species shows seven types of trichomes
(Plate 22; Figs. 211-217).

1. Unicellular papillose

Foot : Not visible. Body : Entire, hyaline, papillose, tip pointed; wall thin and smooth; lumen wide; content translucent (Fig. 211).

Distrib. : Stigma.

2. Unicellular flagellate

Foot : Simple. Body : Entire, flagellate, tip rounded; wall thin and smooth; lumen wide, narrow at distal end; content translucent (Fig. 212).

Distrib. : Corolla - lower surface.

3. Unicellular conical

Foot : Simple. Body : Entire, conical, tip pointed; wall thick and rugose; lumen wide; content translucent (Fig. 213).

Distrib. : Leaf margin, Bract - tips, Pedicel, and Calyx margin.

4. Unicellular curved

Foot : Simple. Body : Entire, curved, from middle, tip rounded; wall thick and rugose; lumen wide; content translucent (Fig. 214).

Distrib. : Calyx margin.

5. Unicellular dentate

Foot : Compound. Body : Entire, erect, dentate, tip pointed; wall thick and smooth; lumen wide; narrowing towards tip; content translucent (Fig. 215).

Distrib. : Ovary wall and base of style.

6. Peltate porous glandular

Foot : Not visible. Body : Peltate, sessile, multicellular; 1-cell thick; cells arranged around the hollow center; outer wall thin, convex and constricted; lumen wide; content granulated, translucent (Fig. 216).

Distrib. : Stem, Petiole, Leaf, Pedicel, Calyx, and Corolla.

7. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk very long, 1-celled; head large, shield-like, round, multicellular; cells radiate around the terminal end of stalk cells; outer and lateral wall thin and smooth; lumen wide; content granulated, dark of head, translucent that of stalk cell (Fig. 217).

Distrib. : Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 22

Trichomes from various plant parts

Figs. 203-210 : Torenia cordifolia

Fig. 203 : Leaf margin

Fig. 204 : Petiole

Fig. 205 : Leaf margin

Fig. 206 : Calyx margin

Fig. 207 : Petiole

Fig. 208 : Stem

Fig. 209 : Leaf upper surface

Fig. 210 : Anther filament

Figs. 211-217 : Torenia fourneiri

Fig. 211 : Stigma

Fig. 212 : Corolla lower surface

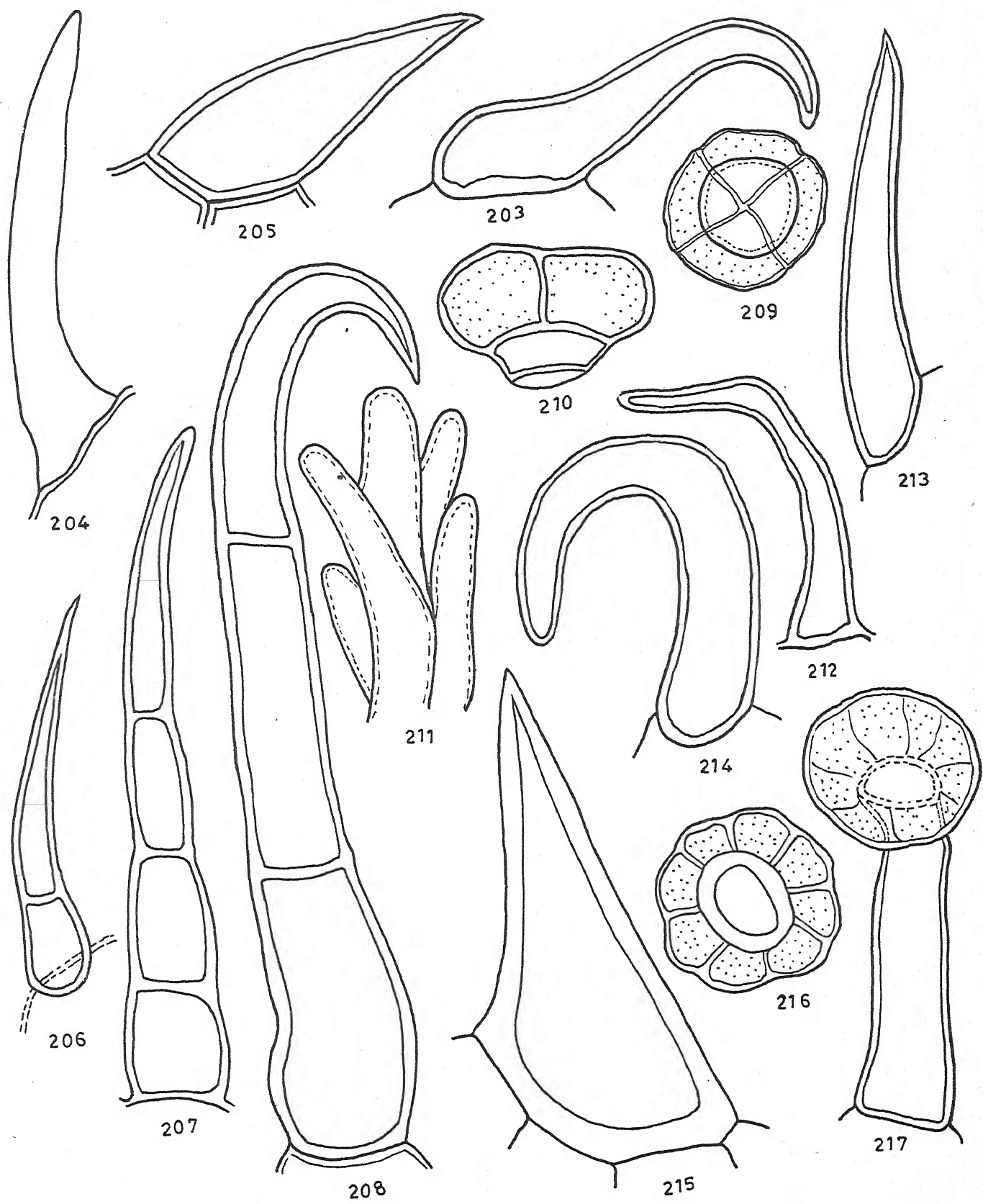
Fig. 213 : Bract

Fig. 214 : Calyx margin

Fig. 215 : Ovary

Fig. 216 : Leaf upper surface

Fig. 217 : Corolla upper "



203,204,205,208,211,215,217

206,207,213,214

209,210,216

212

ALL 50μ

Torenia violacea

This species shows eight types of trichomes
(Plate 23; Figs. 218-226).

1. Unicellular conical

Foot : Simple. Body : Entire, short, erect, conical, tip pointed; wall thick and smooth; lumen wide; content translucent (Fig. 218).

Distrib. : Ovary.

2. Unicellular cylindrical

Foot : Simple. Body : Entire; hyaline, cylindrical, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 219).

Distrib. : Corolla - lower surface.

3. Unicellular dentate

Foot : Simple. Body : Entire, parallel to epidermis, proximal part swollen and spiniferous, distal part smooth, tip pointed, wall thick and smooth; lumen wide in proximal area and narrowing towards distal end; content translucent or opaque (Fig. 220).

Distrib. : Leaf and Bract - margins.

4. Bicellular conical

Foot : Simple. Body : Entire, erect, cells longer than broad; tip pointed; lateral wall thin and rugose; lumen wide; content translucent (Fig. 221).

Distrib. : At the margins of Leaf, Bract, and Calyx.

5. Uniseriate filiform

Foot : Simple. Body : Entire, 4-6 celled, filiform, cells longer than broad; terminal cell narrow, tip pointed; lateral wall thin, spiniferous and rugose; cross walls thin; content translucent (Fig. 222).

Distrib. : Stem, Petiole, Leaf and Bract - margin, Pedicel and Calyx margin.

6. Uniseriate aseptate flagellate

Foot : Simple. Body : 4-5 celled, spiniferous, differentiated; stalk 3-4 celled, cells longer than broad; head 1-cell long, narrow and flagellate, tip rounded; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 223).

Distrib. : Stem, Bract, and Pedicel.

7. Peltate glandular

Foot : Sunken, not visible, except marking. Body : Peltate, 4-celled, sessile, 1-cell thick disc, parallel to epidermis;

cells arranged cross wise; outer wall thin smooth, convex and constricted; lumen wide; content granulated, translucent (Fig. 224).

Distrib. : Stem, Petiole, Leaf, Pedicel.

8. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, discoid; head 1-celled, large, inflated, with starch grains (Fig. 225), or many-celled without starch grains (Fig. 226); outer wall thin or thick and smooth; lumen wide; content light granulated or dark of head, and translucent of stalk (Figs. 225 & 226).

Distrib. : Corolla - margin, Anther filaments, and Sheath.

Vandellia mollis

This species shows eleven types of trichomes (Plate 23; Figs. 227-237).

1. Unicellular papillose

Foot : Not visible. Body : Entire, hyaline papillose, tip rounded; wall thin and torulose; lumen wide; content light (Fig. 227).

Distrib. : Corolla - lower surface, and Stigma.

2. Unicellular flagellate

Foot : Simple. Body : Entire, very long, tubular,

flagellate, tip pointed; wall thin and smooth; lumen narrow; content translucent (Fig. 228).

Distrib. : Stem, and Pedicel.

3. Unicellular acuminate

Foot : Simple. Body : Entire, long, erect, narrowing towards pointed tip; wall thin and smooth; lumen wide; content translucent (Fig. 229).

Distrib. : Stem, Leaf - lower surface, Pedicel, and Calyx.

4. Unicellular conical

Foot : Not visible. Body : Entire, erect, conical, tip pointed, wall thin straight and smooth; lumen wide; content translucent (Fig. 230).

Distrib. : Leaf and Calyx - upper surface & margin.

5. Unicellular hooked

Foot : Simple. Body : Entire, sharply bent on one side from base, tip pointed; wall thin, straight and smooth; lumen wide; content translucent (Fig. 231).

Distrib. : Calyx margin.

6. Unicellular curved

Foot : Simple or compound. Body : long, curved at the middle, tip pointed; wall thin and smooth; lumen wide,

content translucent (Fig. 232).

Distrib. : Leaf - lower surface, Pedicel and Calyx - lower surface.

7. Bicellular acuminate

Foot : Simple. Body : Entire, erect, upper cell longer, narrowing to pointed tip; wall thick and smooth; lumen wide; content translucent (Fig. 233).

Distrib. : Stem, and Leaf - lower surface.

8. Uniseriate acuminate

Foot : Simple. Body : 3-5 celled, entire, straight, acuminate, tip shapely pointed; cells much longer than broad; lateral wall thick and smooth; cross walls thin; lumen wide; content translucent (Fig. 234).

Distrib. : Stem.

9. Peltate glandular

Foot : Not visible, except marking. Body : Peltate, 4-celled, sessile, 1-cell thick disc, parallel to epidermis; cells arranged crosswise, outer wall thin, convex, smooth and constricted at joints; lumen wide; content granulated translucent (Fig. 235).

Distrib. : Stem, Leaf, Pedicel, and Calyx.

EXPLANATION OF THE FIGURES OF PLATE - 23

Trichomes from various plant parts

Figs. 218-226 : Torenia violacea

Fig. 218 : Ovary

Fig. 219 : Corolla lower surface

Figs. 220, 221 : Leaf margin

Figs. 222, 223 : Stem

Fig. 224 : Leaf upper surface

Fig. 225 : Anther filament

Fig. 226 : Corolla margin

Figs. 227-237 : Vandellia mollis

Fig. 227 : Corolla lower surface

Fig. 228 : Stem

Fig. 229 : Leaf lower surface

Fig. 230 : Leaf margin

Fig. 231 : Calyx margin

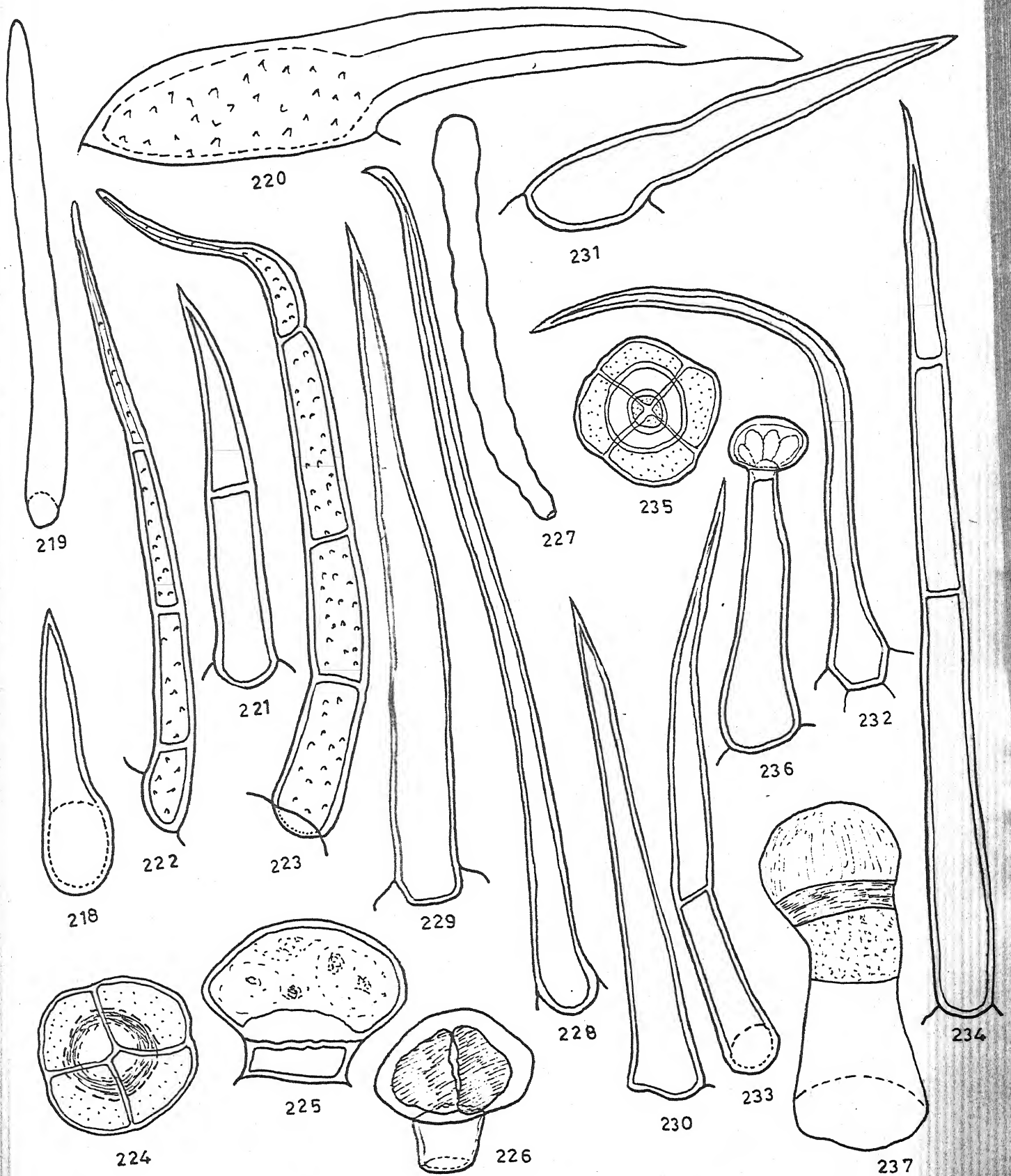
Fig. 232 : Calyx lower surface

Figs. 233, 234 : Stem

Fig. 235 : Leaf upper surface

Fig. 236 : Flower pedicel

Fig. 237 : Corolla lower surface



18, 222, 228, 229, 230, 231, 233, 234

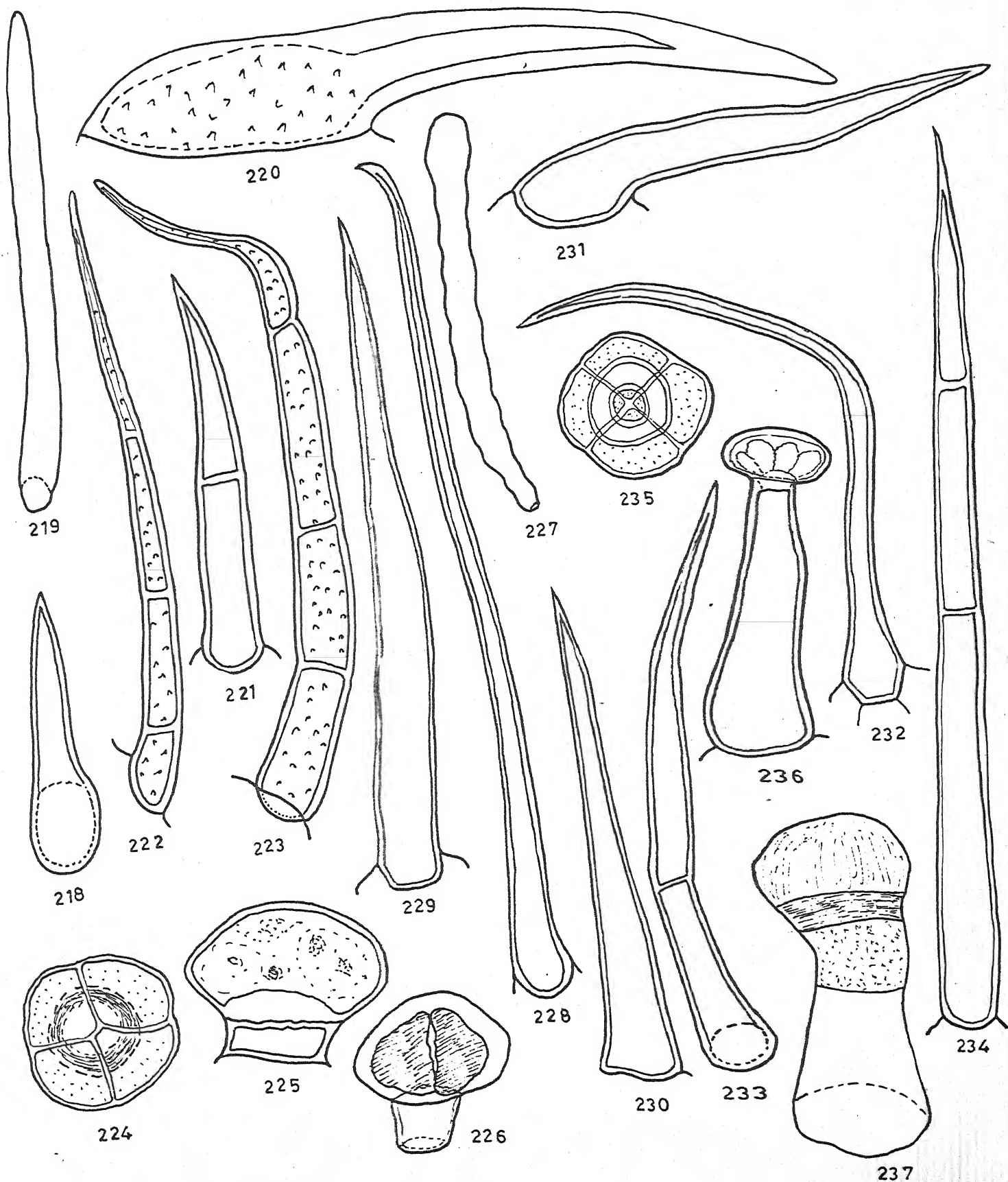
219, 221, 223, 232, 236

220, 237

224, 225, 226, 235

227

ALL 50μ



218, 222, 228, 229, 230, 231, 233, 234

219, 221, 223, 232, 236

220, 237

224, 225, 226, 235

227

ALL 50μ

10. Bicellular glandular capitate

Foot : Simple. Body : Differentiated, stalk 2-celled, basal cell much longer than upper short collared cell; head inflated, 1-celled; outer wall thin and hyaline; lateral wall thin and smooth, content granulated dense of head and collared cell, translucent of basal stalk cell (Fig. 236).

11. Uniseriate glandular

Foot : Simple. Body : Slightly differentiated into 3-4-celled proximal part and terminal rounded glandular cell; cells of varying sizes and shapes; lateral wall thin and smooth; cross walls thin; content dark except basal cell (Fig. 237).

Distrib. : Corolla - lower surface.

Lindernia crustacea

This species shows eleven types of trichomes (Plate 24, Figs. 238-248).

1. Unicellular clavate

Foot : Simple. Body : 1-celled, long, flexuous, distal part swollen club-shaped; wall thin and smooth; lumen wide; content vacuolated, dense and collapsing (Fig. 238).

Distrib. : Corolla - lower surface.

2. Unicellular flagellate

Foot : Simple. Body : Entire, long, flagellate, tip rounded; wall thin and rugose; lumen narrow; content translucent (Fig. 239).

Distrib. : Stem.

3. Unicellular acuminate

Foot : Simple. Body : Entire, erect, acuminate, tip pointed; wall thin and rugose; lumen wide; becoming narrow towards tip; content translucent (Fig. 240).

Distrib. : Calyx.

4. Unicellular conical

Foot : Simple. Body : Entire, erect, conical, tip pointed; wall thin and rugose; lumen wide, narrowing towards tip; content translucent (Fig. 241).

Distrib. : Leaf - lower surface.

5. Unicellular cylindrical

Foot : Simple. Body : Entire, erect, cylindrical, tip rounded; wall thin and rugose; lumen wide; content translucent (Fig. 242).

Distrib. : Anthers - suture.

6. Unicellular curved

Foot : Simple. Body : Entire, curved, tip rounded; wall

thin and rugose; lumen wide; content translucent (Fig. 243).

Distrib. : Stem.

7. Unicellular dentate

Foot : Simple. Body : Stiff, short, dentate, tip pointed; wall thick and verrucose; lumen wide; narrow at distal end; content opaque (Fig. 244).

Distrib. : Leaf - margin and Calyx.

8. Bicellular filiform

Foot : Simple. Body : Entire, filiform, upper cell longer than lower one, tip rounded; lateral wall thin and rugose cross wall thin; lumen wide; content translucent (Fig. 245).

Distrib. : Stem, Leaf - upper surface, Pedicel and Calyx - upper surface.

9. Peltate glandular

Foot : Sunken, only marking visible. Body : Peltate.

4-celled, sessile, 1-cell thick disc, cells arranged cross wise, parallel to epidermis; outer wall thin, smooth and convex; lumen wide; content granulated, translucent (Fig. 246).

Distrib. : Stem, Leaf - upper surface, Pedicel, Calyx - upper surface, and Corolla.

10. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, broader than longer; head globular, glandular, dome of many cells; cells large directly seated on the stalk cell; outer wall prominent and smooth; lumen wide; content granulated dense (Fig. 247).

Distrib. : Corolla - upper surface and Anthers.

11. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, basal cell much longer and broader than upper short collared cell; head 1-celled, large, spherical, outer wall thin and smooth; content granulated dark of head and collared cell, translucent that of basal stalk cell (Fig. 248).

Distrib. : Corolla - lower surface.

Lindernia ciliata

This species shows three types of trichomes (Plate 24, Figs. 249-251).

1. Unicellular dentate

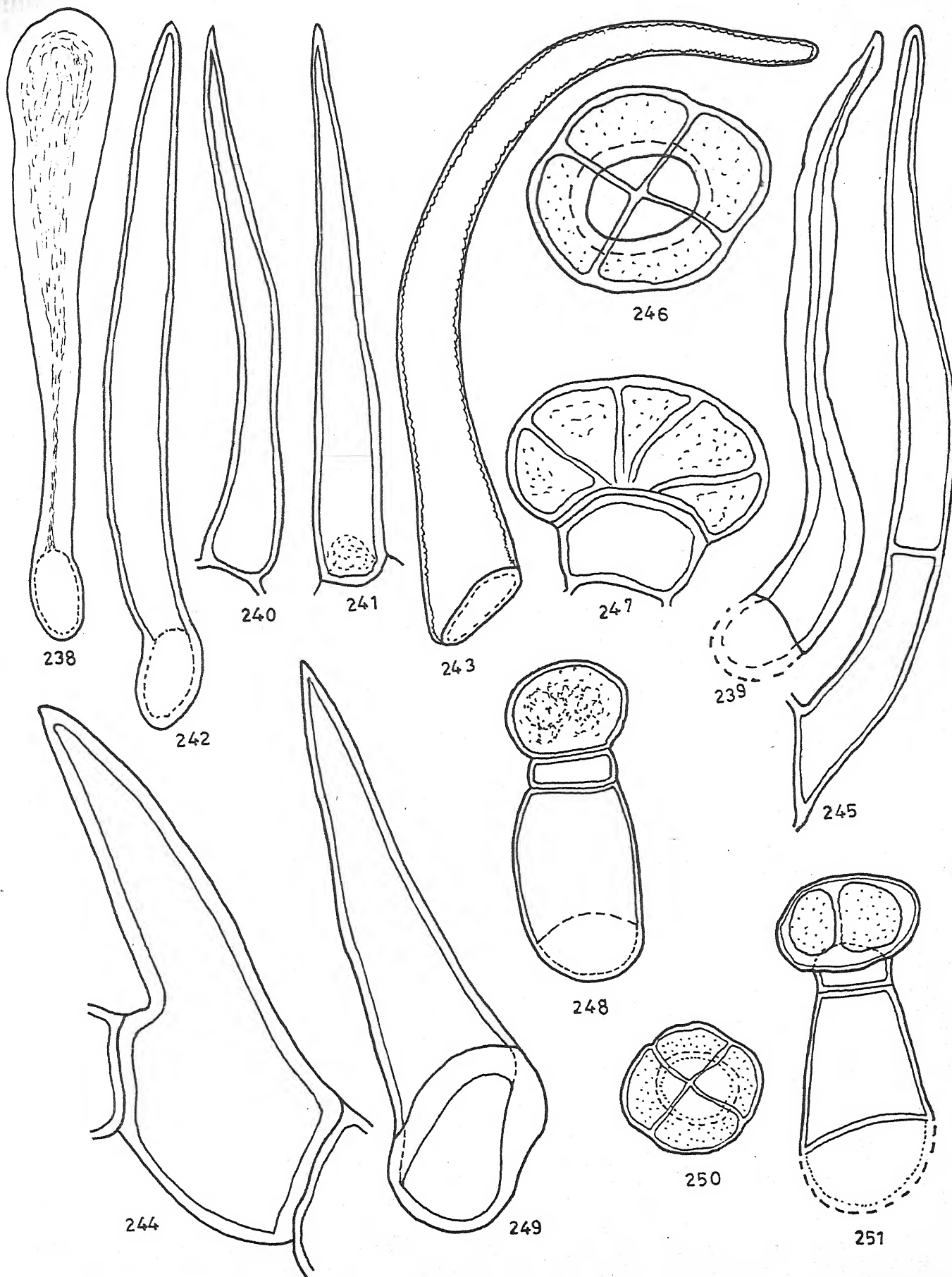
Foot : Simple. Body : Entire, erect, dentate, tip pointed; wall thin or thick and verrucose; lumen wide or narrow; content opaque (Fig. 249).

Distrib. : Stem, Leaf, Bract - margin and Calyx.

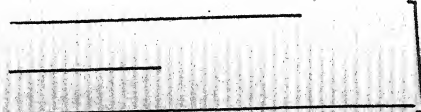
EXPLANATION OF THE FIGURES OF PLATE - 24

Trichomes from various plant parts

- Figs. 238-248 : Lindernia crustacea
- Fig. 238 : Corolla lower surface
- Fig. 239 : Stem
- Fig. 240 : Calyx upper surface
- Fig. 241 : Leaf lower "
- Fig. 242 : Anther filament
- Fig. 243 : Stem
- Fig. 244 : Leaf margin
- Fig. 245 : Stem
- Fig. 246 : Calyx upper surface
- Fig. 247 : Corolla upper "
- Fig. 248 : Corolla lower "
- Figs. 249-251 : Lindernia ciliata
- Fig. 249 : Leaf upper surface
- Fig. 250 : Stem
- Fig. 251 : Corolla lower surface



238, 241, 242, 243, 244, 245, 249
 239, 240
 246, 247, 248, 250, 251



ALL 50 μ

2. Peltate glandular

Foot : Sunken, only marking visible. Body : Circular, 4-celled, Peltate, 1-cell thick, parallel to epidermis; cells arranged crosswise; outer wall thin and smooth; lumen wide; content light granulated (Fig. 250).

Distrib. : Stem, Leaf, Bract, and Calyx.

3. Bicellular glandular capitate

Foot : Simple. Body : Differentiated, stalk 2-celled, lower cell much longer than upper short collared cell; head globular 4-celled; outer wall thick and smooth; lumen wide; content translucent (Fig. 251).

Distrib. : Corolla - lower surface.

Lindernia parviflora

This species shows three types of trichomes (Plate 25, Figs. 252-254).

1. Unicellular flagellate

Foot : Simple. Body : Entire, hyaline, flagellate, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 252).

Distrib. : Corolla - upper surface.

2. Unicellular dentate

Foot : Compound. Body : Stout, fusiform, dentate, tip

pointed; wall thin and smooth; lumen wide; content translucent (Fig. 253).

Distrib. : Leaf margin.

3. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, long or short, both cells are equal sized or lower cell longer than upper short collared cell; head peltate, multicellular, cells arranged around common center. Walls thick and smooth; lumen wide; content granulated and translucent (Fig. 254).

Distrib. : Pedicel, Calyx, and Corolla - upper surface.

Angelonia grandiflora

This species shows five types of trichomes (Plate 25, Figs. 255-259).

1. Peltate porous glandular

Foot : Not visible. Body : Peltate, multicellular, shield-like 1-cell thick, parallel to epidermis, cells radiating from central hollow part; outer wall thin and smooth; content dark (Fig. 255).

Distrib. : Leaf.

2. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head very large, 1-celled, striated; outer wall thin and

ridged; lumen wide; content dark and granulated (Fig. 256).

Distrib. : Corolla - upper surface.

3. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, cells rectangular; head large, oval, 2-4 celled, striated, outer wall thin and smooth; lumen wide; content dark of head, and translucent that of stalk (Fig. 257).

Distrib. : Calyx - lower surface, and Ovary.

4. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-5 celled, terminal cell short collared one; head 1-celled, oval, with long dark striation, outer wall thin and lateral wall thin and slightly convex; cross walls thin; lumen wide; content dark of head, granulated, collapsing of stalk cells (Fig. 258).

Distrib. : Anther filaments, Style, and Ovary.

5. Unicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk very long, multicellular, cells longer than broad, except terminal short collared one; head large, globular, multicellular; outer wall thin, smooth and vesiculate, with an apical pouch; content dark of head and granulated, evanescent that of stalk (Fig. 259).

Distrib. : Stem, Leaf, Pedicel, and Calyx.

EXPLANATION OF THE FIGURES OF PLATE - 25

Trichomes from various plant parts

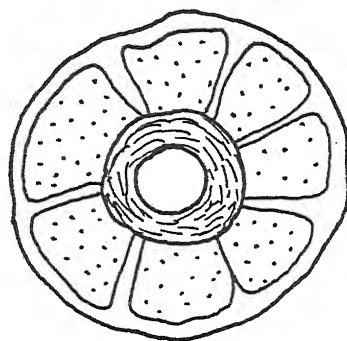
- Figs. 252-254 : Lindernia parviflora
Fig. 252 : Corolla upper surface
Fig. 253 : Leaf margin
Fig. 254 : Flower pedicel
- Figs. 255-259 : Angelonia grandiflora
Fig. 255 : Leaf upper surface
Fig. 256 : Corolla upper "
Fig. 257 : Corolla lower "
Fig. 258 : Anther filament
Fig. 259 : Calyx upper surface



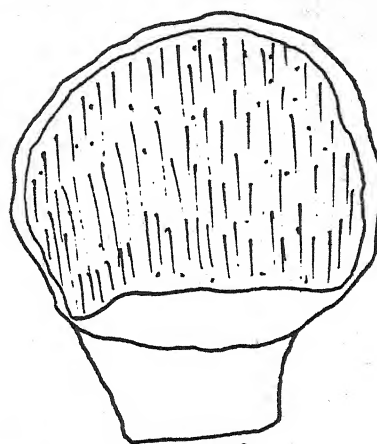
252



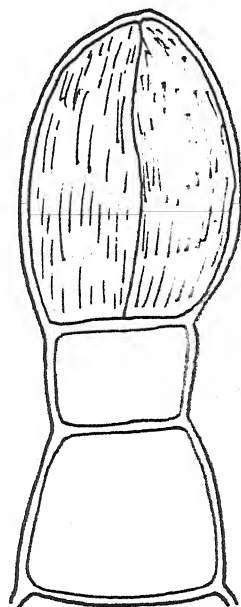
254



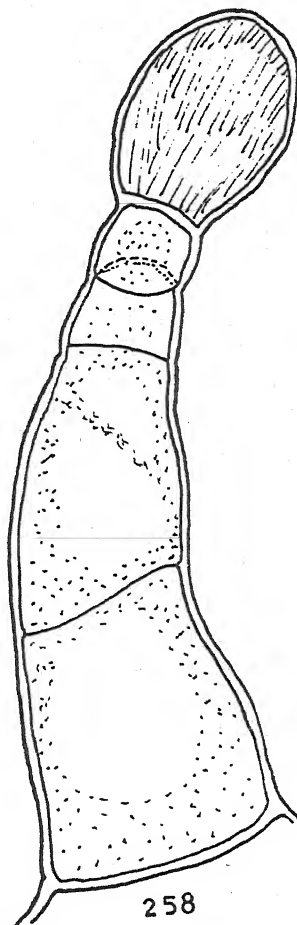
255



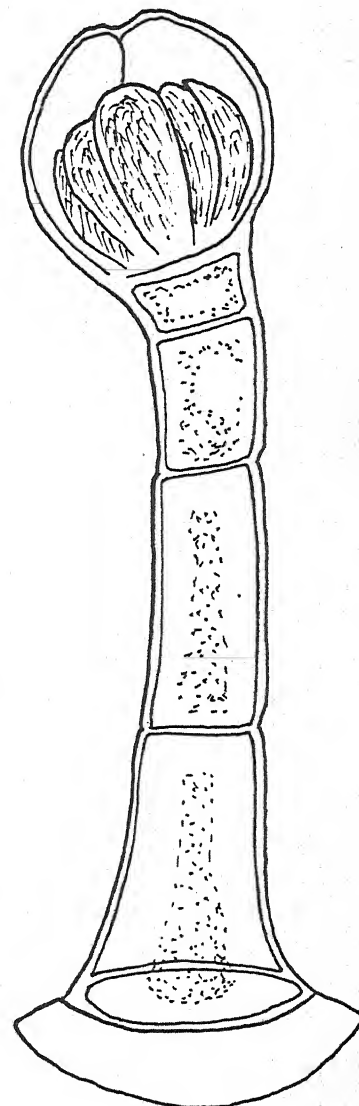
256



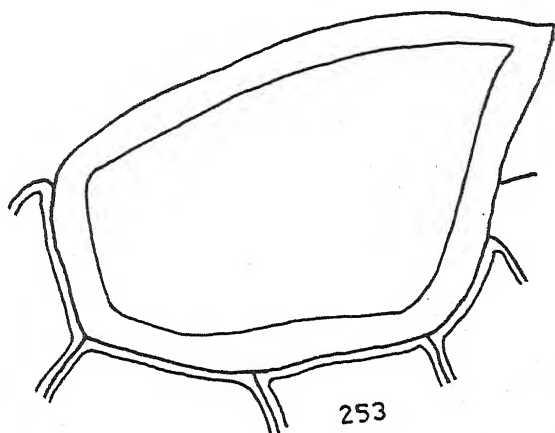
257



258



259



253

252, 257, 258, 259

253, 254, 255, 256

ALL 50 μ

Angelonia gardeneri

This species shows four types of trichomes
(Plate 26; Figs. 260-265).

1. Peltate perous glandular

Foot : Not visible except marking. Body : Peltate, multi-cellular, sessile 1-cell thick disc, parallel to epidermis; cells radiating from central hollow region; outer wall thin, smooth and convex; lumen wide, content granulated translucent (Fig. 260).

Distrib. : Leaf, Pedicel and Calyx - upper surface.

2. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short or long. 2-celled, cells rectangular; head, globular, 2-4 celled; cells large, glandular and arranged in a tier; walls thin and smooth; content granulated, translucent (Fig. 261).

Distrib. : Corolla and Ovary.

3. Uniseriate glandular

Foot : Simple. Body : Differentiated; stalk, 3-celled, long or short, cells longer than broad (Fig. 262) or rectangular (Fig. 263); head 1-celled, oblong, short (Fig. 262) or quite large (263), terminal glandular cell different from rest of stalk cells, revealing vertical, dark, prominent

striations; walls thin or thick and smooth; lumen wide; content dark of head, translucent that of stalk (Figs. 262 & 263).

Distrib. : Corolla - upper surface, Anthers - filament, basal and middle part of Style and Ovary.

4. Uniseriate glandular capitate

Foot : simple. Body : Differentiated, stalk long, 3-5 celled, cells longer than broad in some, basal cell pulvinate and striated (Fig. 251); head, 2-4 celled, globular or cordate, cells large, arranged in one tier; walls thin and smooth; content dark, yellowish and granulated (Figs. 264, 265).

Distrib. : Stem, Leaf, Pedicel, and Calyx.

Calceolaria mexicana

This species shows three types of trichomes (Plate 26; Figs. 266-268).

1. Unicellular dentate

Foot : simple. Body : Entire, dentate, tip pointed; wall thick and smooth, lumen wide; content translucent (Fig. 266).

Distrib. : Calyx - upper surface.

2. Uniseriate filiform

Foot : Simple. Body : Entire, 3-5 celled, filiform; cells much longer than broad, tip rounded; lateral and cross walls thin, and smooth; lumen wide; content translucent, with scanty starch grains (Fig. 267).

Distrib. : Stem.

3. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 5-10 celled, cells longer than broad, except short terminal collared one; head globular, multicellular, elongated glandular cells arranged in one vertical tier; lateral wall thin, smooth, and slightly convex, constricted at joints; outer wall thick; cross walls thin; content dark of head and collared cell, translucent that of stalk, starch grains found throughout the body (Fig. 268).

Distrib. : Stem, Leaf, Calyx, and Ovary.

Calceolaria gracilis

This species shows four types of trichomes (Plate 26; Figs. 269-272).

1. Bicellular filiform

Foot : Simple. Body : Entire, short, filiform, upper cell longer than basal one, tip rounded; lateral wall thin and

smooth; lumen narrow; content translucent (Fig. 269).

Distrib. : Stem.

2. Uniseriate filiform

Foot : Simple. Body : Entire, 3-5 celled, filiform, tip rounded; cells longer than broad, basal cell pulvinus; lateral and cross walls thin; lumen wide; content translucent (Fig. 270).

Distrib. : Stem.

3. Uniseriate glandular

Foot : Simple. Body : 3-5 celled, undifferentiated except terminal cell; cells broader than longer, terminal cell large, globular and glandular, walls thin and smooth; lumen wide; content translucent (Fig. 271).

Distrib. : Corolla - tips.

4. Uniseriate glandular capitate

Foot : Compound. Body : Differentiated; stalk long, 3-8 celled; cells longer than broad, except short terminal collared one; head large, 2-4 celled, cells longer, arranged lengthwise in a tier; walls thin and smooth; lumen wide; content striated, granular, dark of head and collared cell, and translucent that of stalk (Fig. 272).

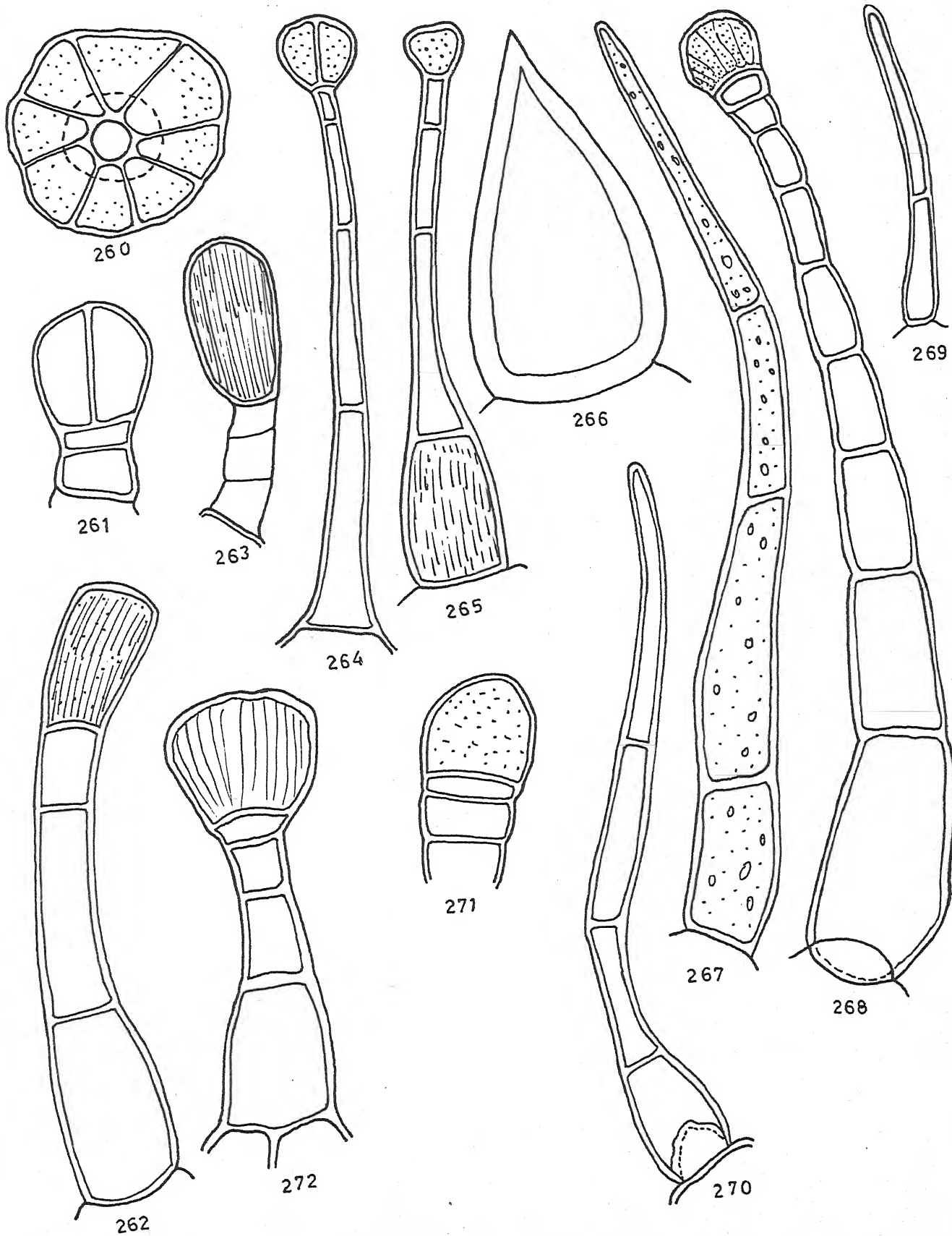
Distrib. : Stem, Leaf, Calyx, and Ovary.

EXPLANATION OF THE FIGURES OF PLATE - 26

Trichomes from various plant parts

- Figs. 260-265 : Angelonea gardeneri
Fig. 260 : Leaf upper surface
Fig. 261 : Ovary
Fig. 262 : Anther filament
Fig. 263 : Corolla upper surface
Fig. 264 : Stem
Fig. 265 : Leaf upper surface
Figs. 266-268 : Calceolaria mexicana
Fig. 266 : Calyx upper surface
Figs. 267, 268 : Stem

Figs. 269-272 : Calceolaria gracilis
Figs. 269, 270 : Stem
Fig. 271 : Corolla tube
Fig. 272 : Calyx upper surface



260
 261, 266, 267, 271
 262, 263, 264, 265, 269, 270, 272
 268

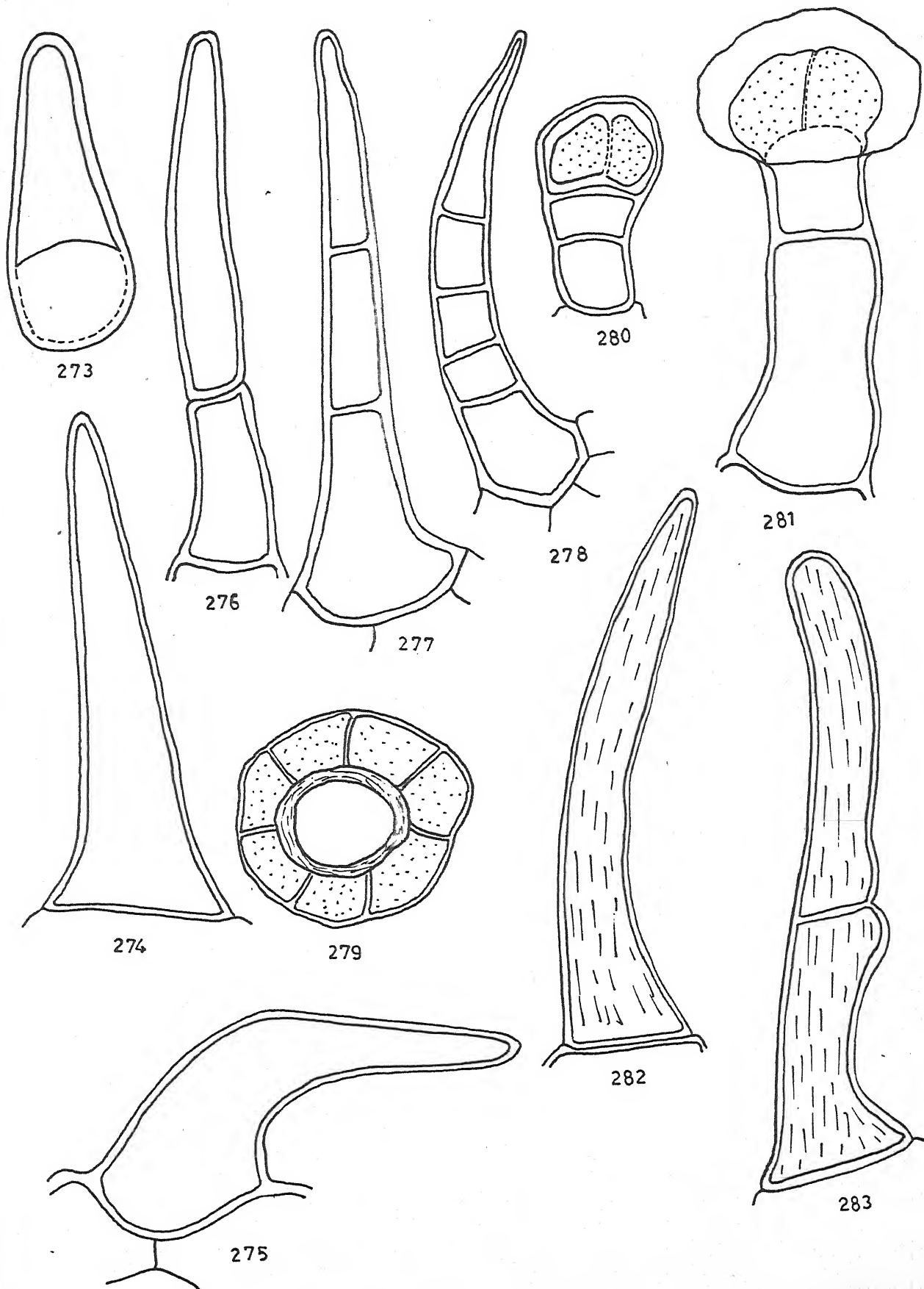
ALL 50μ

EXPLANATION OF THE FIGURES OF PLATE - 27

Trichomes from various plant parts

- Figs. 273-281 : Russelia equisetiformis
Fig. 273 : Stem
Fig. 274 : Leaf lower surface
Fig. 275 : Leaf margin
Figs. 276-278 : Stem
Fig. 279 : Leaf upper surface
Fig. 280 : Calyx upper "
Fig. 281 : Corolla lower "

Figs. 282-283 : Russelia coccinia
Fig. 282 : Leaf
Fig. 283 : Stem



273, 275, 279, 280, 281

274, 276, 277, 282, 283

278

ALL 50μ

Russelia equisetiformis

This species shows eight types of trichomes
(Plate 27, Figs. 273-281).

1. **Unicellular papillose**

Foot : Simple. Body : Entire, erect, short, papillose, tip rounded; wall thin and smooth; lumen wide; content translucent (Fig. 273).

Distrib. : Stem.

2. **Unicellular conical**

Foot : Simple. Body : Entire, erect, conical, tip rounded; wall thick and smooth; lumen wide; content dark yellow (Fig. 274).

Distrib. : Leaf.

3. **Unicellular hooked**

Foot : Simple. Body : 1-celled, short sharply bent to one side as hook, tip rounded; wall thin and smooth; lumen wide, narrowing above, content light yellow (Fig. 275).

Distrib. : Leaf margin, and bract.

4. **Bicellular cylindrical**

Foot Simple. Body : Entire, erect, cylindrical, tip rounded; lateral and cross walls thin and smooth; lumen wide;

content dark yellow (Fig. 276).

Distrib. : Stem, Leaf - upper surface, and Bract.

5. Uniseriate filiform

Foot : Compound. Body : 3-5 celled, entire, erect, filiform, tip rounded; cells longer than broad; lateral wall thick and rugose; cross walls thin; lumen wide; content light yellow (Fig. 277).

Distrib. : Stem, and Leaf.

6. Uniseriate conical

Foot : Compound. Body : 4-6 celled, entire, conical, slightly curved; cells of various sizes and shapes; terminal cell longer, tip rounded; lateral and cross walls thick and smooth; lumen wide; content light yellow (Fig. 278).

Distrib. : Stem, and Leaf - upper surface.

7. Peltate porous glandular

Foot : Not visible. Body : Peltate multicellular, 1-cell thick; cells arranged around central hollow part; outer wall thin and smooth; content light yellow (Fig. 279).

Distrib. : Leaf.

8. Bicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk 2-celled, short (Fig. 280), or long (Fig. 281), basal cell longer than

upper one (Fig. 281); head 2-4 celled; outer wall thin, smooth and vesiculate; lateral and cross walls thick; content granulated yellow (Fig. 280-281).

Distrib. : Calyx and Corolla.

Russelia coccinea

This species shows seven types of trichomes (Plate 27-28; Figs. 282-288).

1. Unicellular cylindrical

Foot : Simple. Body : Entire, erect, cylindrical, striated, tip rounded; wall thin and smooth; lumen wide; content dark yellowish (Fig. 282).

Distrib. : Stem, Leaf - tip and base.

2. Bicellular cylindrical

Foot : Simple. Body : Entire, erect cylindrical, striated, basal cell bulged on one side, tip rounded; lateral wall thick and smooth; lumen wide; content dark yellow (Fig. 283).

Distrib. : Stem and Leaf.

3. Bicellular furcate

Foot : Simple. Body : 2-celled, furcate and striated; basal cell, erect, tip proceed as hood; upper cell bifurcate as one celled long lateral appendages, tips rounded; later wall thin and smooth; lumen wide; content dark yellow (Fig. 284).

Distrib. : Leaf.

4. Uniseriate cylindrical

Foot : Simple. Body : 3-celled, entire, long and cylindrical, striated, terminal cell longer than the lower cells, tip rounded; walls thin and smooth; lumen wide; content dark yellow (Fig. 285).

Distrib. : Stem, Leaf - apex and base.

5. Uniseriate furcate

Foot : Simple. Body : 4-5 celled, furcate; lateral branch unicellular, long and curved; cells longer than broad; tips rounded; lateral wall thin and smooth; lumen wide; content dark yellow (Fig. 286).

Distrib. : Stem, and Leaf margin.

6. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head inflated, 1-celled; outer wall thin and smooth; content translucent of head, dark that of stalk (Fig. 287).

Distrib. : Stem, Leaf and Calyx.

7. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, multicellular, basal cell much longer than the upper rectangular cells; head distinct, inflated, 1-celled; walls thin and smooth; lumen wide; content granulated, light yellowish of

head and upper stalk cells, translucent of basal longer stalk cells (Fig. 288).

Distrib. : Corolla and Anther filaments.

Russelia floribunda

This species shows nine types of trichomes (Plate 28; Figs. 289-297).

1. Unicellular papillose

Foot : Simple. Body : Entire, erect, striated, papillose, tip rounded; wall thin and rugose; lumen wide, narrowing towards distal end; content dark yellow (Fig. 289).

Distrib. : Bract, Pedicel, and Calyx margin.

2. Unicellular flagellate

Foot : Simple. Body : Entirely striated, long, flagellate, tip pointed; wall thin and rugose; lumen wide, narrowing towards tip; content bright yellow (Fig. 290).

Distrib. : Leaf and Pedicel.

3. Unicellular hooked

Foot : Simple. Body : 1-celled, deflexed downward, striated, hooked, tip pointed; wall thin and rugose; lumen wide, narrowing towards tip; content dark yellow (Fig. 291).

Distrib. : Bract, Pedicel, and Calyx.

4. Unicellular cylindrical

Foot : Simple. Body : Entire, very long and broad, striated, cylindrical, tip rounded; lateral wall thin and rugose; lumen wide; content dark yellow (Fig. 292).

Distrib. : Corolla - lower surface.

5. Bicellular curved

Foot : Simple. Body : Entire, striated, upper cell longer and curved, tip pointed; lateral wall thin and rugose; lumen wide; content dark yellow (Fig. 293).

Distrib. : Bract - margin and Pedicel.

6. Uniseriate filiform

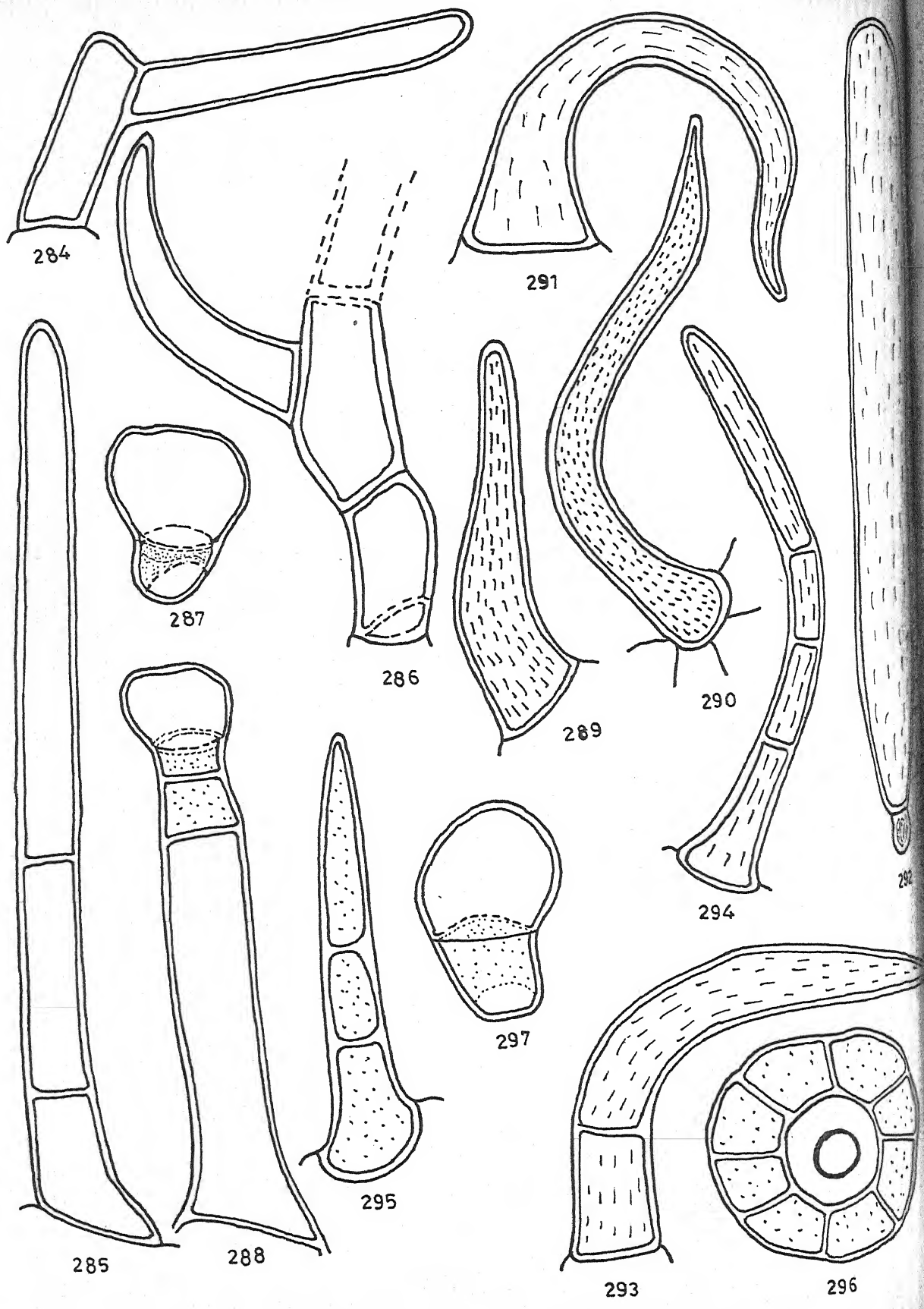
Foot : Simple. Body : Entire, 3-5 celled, striated, filiform, terminal cell longer than the others, tip rounded; lateral wall thin and rugose; lumen wide; content dark yellow (Fig. 294).

Distrib. : Pedicel.

7. Uniseriate conical

Foot : Simple. Body : Entire 3-5 celled, short, conical, striated, terminal cell long, tip pointed; lateral wall thick and rugose; lumen wide; content dark yellow (Fig. 295).

Distrib. : Pedicel.



284, 285, 286, 288, 289, 291, 293
 287, 296, 297
 290, 294, 295
 292

ALL 500

EXPLANATION OF THE FIGURES OF PLATE - 28

Trichomes from various plant parts

Figs. 284-288 : Russelia coccinia

Fig. 284 : Leaf

Figs. 285, 286 : Stem

Fig. 287 : Calyx upper surface

Fig. 288 : Corolla lower "

Figs. 289-297 : Russelia floribunda

Fig. 289 : Bract

Fig. 290 : Flower pedicel

Fig. 291 : Bract

Fig. 292 : Corolla lower surface

Fig. 293 : Bract

Fig. 294 : Flower pedicel

Fig. 295 : Flower pedicel

Fig. 296 : Leaf upper surface

Fig. 297 : Calyx lower "

8. Peltate porous glandular

Foot : Not visible except marking. Body : Peltate, multicellular, shield-like, 1-cell thick disc, cells arranged in a circular tier around the porous centre; outer wall thin, slightly convex and smooth; lumen wide; content granulated and translucent (Fig. 296).

Distrib. : Stem and Leaf.

9. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head 1-celled, inflated, globular; outer wall thin; lumen wide; content translucent of head and dark of stalk cell (Fig. 297).

Distrib. : Calyx and Corolla - lower surface.

Collinsia bicolor

This species shows six types of trichomes (Plate 29; Figs. 298-302).

1. Unicellular papillose

Foot : Simple. Body : 1-celled, hyaline, variously shaped, tip pointed or rounded; lateral wall thin and smooth; lumen wide; content translucent (Fig. 298).

Distrib. : Stem and Corolla - lower surface.

2. Unicellular cylindrical

Foot : Simple. Body : Entire, cylindrical, tip rounded; lateral wall thin and smooth; lumen wide and varied; content translucent (Fig. 299).

Distrib. : Stem and Calyx - lower surface.

3. Unicellular dentate

Foot : Compound. Body : Entire, dentate, tapering; lateral wall thick and smooth; lumen wide, narrow at distal end; content opaque (Fig. 300).

Distrib. : Calyx - margin.

4. Unicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk 1-celled, very short; head large, 2-4 celled, inflated; outer wall thin, smooth and vesiculate; cross wall thin; content light, granulated of head and dark of stalk (Fig. 301).

Distrib. : Corolla - lower surface and margin.

5. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 2-celled, lower cell much longer than upper, short, collared one; head 4-celled, emarginate, cells arranged cruciately; lateral and outer walls thin and smooth; cross wall thin; content dark of head & collared cell, and translucent that

of basal stalk cell (Fig. 302).

Distrib. : Calyx.

6. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-celled long, flexuous, middle cell very long and narrow, terminal cell short collared; head, small, 4-celled; outer and lateral walls thin and smooth; content dark of head, 4 collared cell, and translucent that of remaining stalk cells (Fig. 303).

Distrib. : Calyx - upper surface.

Nemesia strumosa

This species shows four types of trichomes
(Plate 29; Figs. 304-309).

1. Unicellular clavate

Foot : Not visible. Body : Entire, long, tubular, tip swollen, club-shaped; wall thin and rugose; lumen narrow; content light granulated (Fig. 304).

Distrib. : Corolla - lower surface.

2. Peltate glandular

Foot : Not visible, except marking. Body : Peltate, circular, discoid, parallel to epidermis, 1-cell thick,

4- (Fig. 305), to many-celled (Fig. 306) in diameter; cells rectangular, radiating from centre; outer wall thin and smooth; lumen wide; content dark (Fig. 305 & 306).

Distrib. : Stem, Leaf, and Corolla - upper surface.

3. Unicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk 1-celled, short, cell rectangular; head large, 4-celled, cells wide, arranged in one tier; outer wall thin, vesiculate and smooth; content dark (Fig. 307).

Distrib. : Anther filaments.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, short (Fig. 308) or basal cell very long, cylindrical, upper cell collared (Fig. 309); head large, 1-celled (Fig. 308) or multicellular, cells elongated, arranged laterally in one tier (Fig. 309); outer wall thin and smooth; content light, granulated of head, dark of collared cell and translucent of remaining stalk cell (Fig. 308 & 309).

Distrib. : Pedicel, Calyx and Corolla - lower surface & margin.

EXPLANATION OF THE FIGURES OF PLATE - 29

Trichomes from various plant parts

Figs. 298-303 : Collinsia bicolor

Fig. 298 : Corolla lower surface

Fig. 299 : Calyx lower "

Fig. 301 : Corolla margin

Figs. 302, 303 : Calyx upper surface

Figs. 304-309 : Nemesia strumosa

Fig. 304 : Corolla lower surface

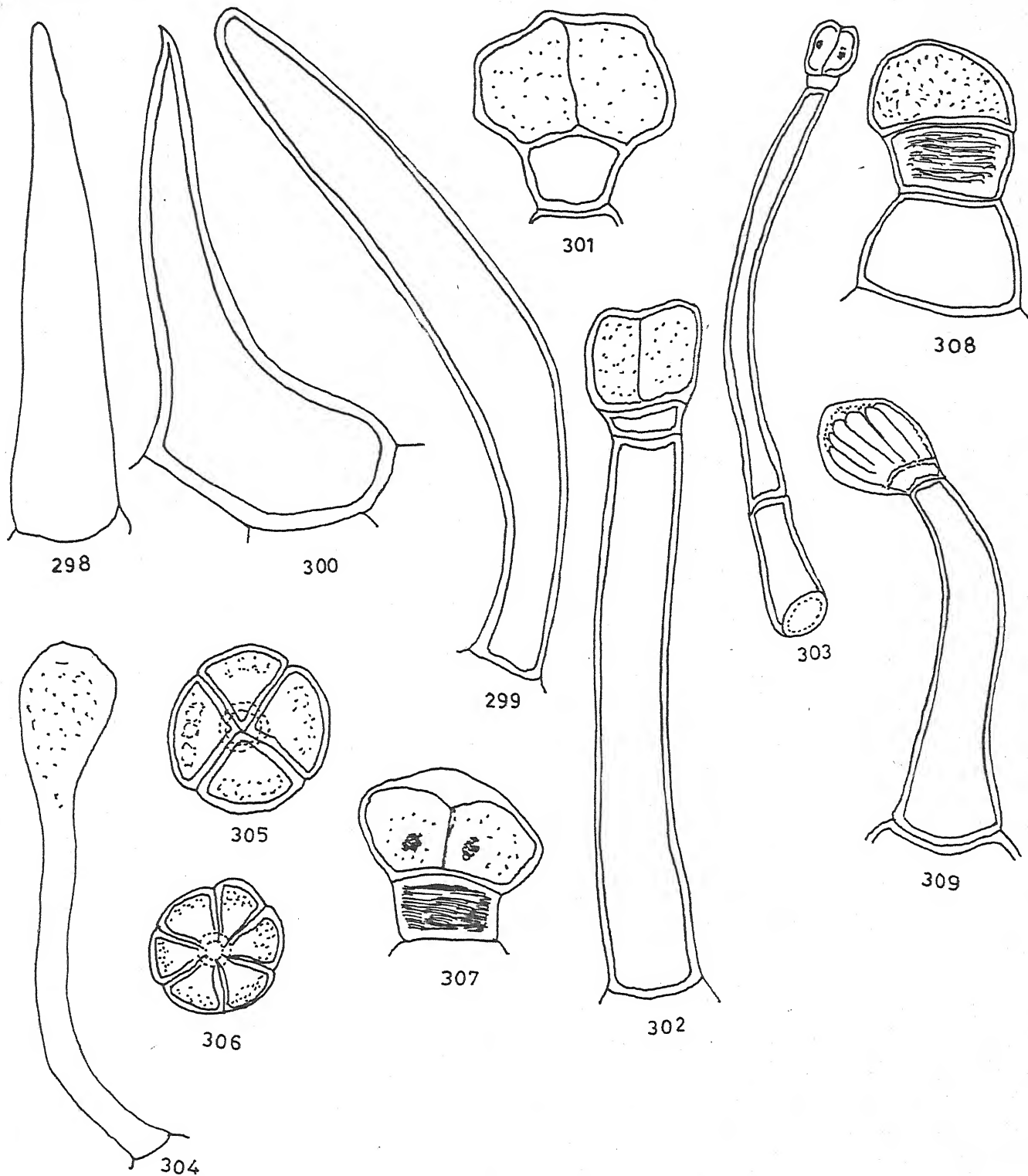
Fig. 305 : Stem

Fig. 306 : Corolla upper surface

Fig. 307 : Anther filament

Fig. 308 : Corolla margin

Fig. 309 : Flower pedicel



298	_____	} ALL 50μ
299,300,302	_____	
301,305,306,307,308	_____	
303,304,309	_____	

(c) SERIES - RHINANTHIDEAE

Thirty nine species belonging to twelve genera of the series Rhinanthideae have been studied for their trichomes. Structural details of trichomes and their distribution on various parts of the individual species are given below:

Hemiphragma heterophyllum

This species shows four types of trichomes (Plate 30; Figs. 1-4).

1. Uniseriate filiform

Foot : Simple. Body : 6-8 celled, entire, erect, filiform; cells longer than broad, tip round; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 1).
Distrib. : Leaf - lower surface.

2. Uniseriate conical

Foot : Simple. Body : 3-5 celled, entire, conical, cells longer than broad, terminal cell short, tip pointed; lateral wall thick and smooth; cross walls thin; lumen wide; content opaque (Fig. 2).
Distrib. : Leaf.

3. Peltate glandular

Foot : Not visible except marking. Body : Peltate, 2-4 celled, parallel to epidermis; cells arranged laterally; outer wall thin and smooth; lumen wide; content granulated yellowish (Fig. 3).

Distrib. : Leaf.

4. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 5-6 celled; cells longer than broad except terminal short collared one, flexuous; head small, globular, 1-celled; outer, lateral and cross walls thin and smooth; content light yellowish (Fig. 4).

Distrib. : Leaf.

Scoparia dulcis

This species shows two types of trichomes (Plate 30; Figs. 5-6).

1. Unicellular papillose

Foot : Simple. Body : Entire, erect, tip round; lateral wall thick and smooth; lumen wide; content light granulated and collapsing (Fig. 5).

Distrib. : Stem.

2. Peltate porous glandular

Foot : Not visible. Body : Peltate, sessile, multicellular, 1-cell thick, parallel to epidermis; cells arranged around the periphery of central hollow part; outer wall thin, vesiculate, enclosing the body partially; cross walls thin; lumen wide; content granulated dense (Fig. 6).

Distrib. : Stem, Petiole, Leaf, and Calyx.

Wulfenia anherstiana

This species shows four types of trichomes (Plate 30; Figs. 7-10).

1. Uniseriate curved

Foot : Simple. Body : 4-6 celled, entire, curved, tip round; cells of varied lengths; lateral wall thin and rugose; cross walls thin; lumen narrow; content light yellowish and granulated (Fig. 7).

Distrib. : Inflorescence axis.

2. Uniseriate septate flagellate

Foot : Simple. Body : 6-15 celled, very long, narrow, flagellate, tip round; cells longer than broad; lateral wall thin and verrucose; lumen narrow; content light yellowish (Fig. 8).

Distrib. : Petiole, Leaf, Inflorescence axis, Bract, and Calyx.

3. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk, 1-celled, distal part broader; head, 4-celled, elongated cells arranged lengthwise in a tier and laterally opposed; outer wall thin and smooth; lumen wide; content light granulated (Fig. 9).
Distrib. : Petiole, Leaf, Inflorescence axis, and Bract.

4. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-10 celled, cells longer than broad; head globular 1-celled; walls thin and smooth; lumen wide; content light yellowish (Fig. 10).

Distrib. : Inflorescence axis, Bract and Calyx - lower surface.

Veronica angalis-aquatica

This species shows only one type of trichome (Plate 30, Fig. 11).

1. Uniseriate glandular

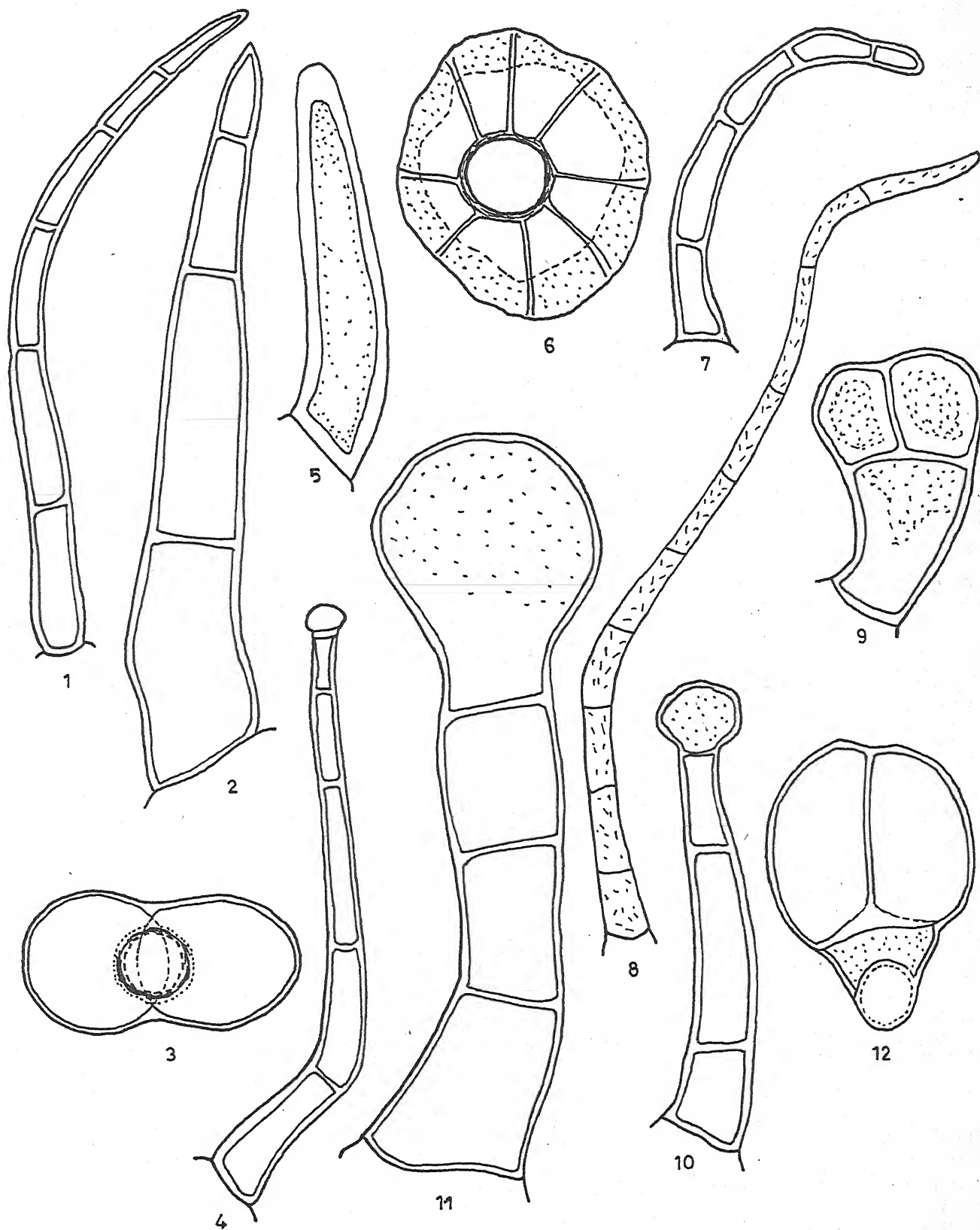
Foot : Simple. Body : Differentiated; stalk 3-4 celled, hyaline, long; cells rectangular except terminal large inflated glandular one; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 11).

Distrib. : Pedicel, Bract - lower surface, Calyx.

EXPLANATION OF FIGURES OF PLATE - 30

Trichomes from various plant parts

- | | | |
|------------|---|------------------------------------|
| Figs. 1-4 | : | <u>Hemiphragma heterophyllum</u> |
| Fig. 1 | : | Leaf lower basal part |
| Figs. 2, 3 | : | Leaf |
| Fig. 4 | : | Leaf margin |
| Figs. 5, 6 | : | <u>Scoperia dulcis</u> |
| Figs. 5, 6 | : | Stem |
| Figs. 7-10 | : | <u>Wulfenia amherstiana</u> |
| Fig. 7 | : | Inflorescence axis |
| Fig. 8 | : | Calyx |
| Fig. 9 | : | Petiole |
| Fig. 10 | : | Inflorescence axis |
| Fig. 11 | : | <u>Veronica anagallis-aquatica</u> |
| | | Flower pedicel |
| Fig. 12 | : | <u>Veronica beccabunga</u> |
| | | Leaf |



1,2,4,7
3,6,9,11,12
5,10
8

ALL 50 μ

Veronica beccabunga

This species shows only one type of trichome
(Plate 30; Fig. 12).

1. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head distinct, large, 2-4 celled, cells arranged vertically in a tier; outer wall thin, convex and smooth; lumen wide, content granulated, translucent of head, dense yellowish that of stalk cell (Fig. 12).

Distrib. : Leaf, Inflorescence axis, Bract, and Calyx.

Veronica agrestis

This species shows three types of trichomes
(Plate 31; Figs. 13-16).

1. Unicellular papillose

Foot : Simple. Body : 1-celled, short, papillose, tip round; wall thin, rugose and uneven; Lumen wide; content translucent (Fig. 13).

Distrib. : Corolla - lower surface, and Anther - base of the filaments.

2. Unicellular filiform

Foot : Simple. Body : Entire, erect, long, tubular.

striated, filiform, tip rounded; wall thin and smooth; lumen wide, content translucent (Fig. 14).

Distrib. : Anther.

3. Unicellular conical

Foot : Simple. Body : Entire, erect, short, conical, striated (Fig. 16) or smooth (Fig. 15); tip pointed; wall thin and smooth; lumen wide; content translucent or dense (Fig. 15 & 16).

Distrib. : Corolla - upper surface and basal area of lower surface.

Veronica persica

This species shows nine types of trichomes (Plate 31; Figs. 17-26).

1. Unicellular hooked

Foot : Simple. Body : Entire, bent sharply at base, hooked, tip pointed; wall thin and rugose; lumen wide; content translucent (Fig. 17).

Distrib. : Stem and Pedicel.

2. Bicellular conical

Foot : Simple. Body : Entire, stout, erect, basal cell longer and broader than upper one, tip pointed; lateral wall thick and rugose; lumen wide; content translucent (Fig. 18).

Distrib. : Leaf margin and Calyx.

3. Bicellular curved

Foot : Simple. Body : 2-celled, entire, elongated cells curved on one side, tip pointed; lateral wall thin and rugose; cross wall thin, lumen wide; content translucent (Fig. 19).

Distrib. : Stem and Pedicel.

4. Uniseriate filiform

Foot : Compound. Body : 6-9 celled, entire, erect, filiform, cells longer than broad, tip pointed; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 20).

Distrib. : Stem and Calyx margin.

5. Uniseriate conical

Foot : Compound. Body : 3-celled, entire, short, erect, conical, tip pointed; lateral wall thick and verrucose; cross walls thick; lumen wide, content translucent (Fig. 21).

Distrib. : Stem, Leaf, and Calyx margins.

6. Uniseriate hooked

Foot : Simple. Body : Entire, 4-6 celled, hooked; cells elongated, terminal cell tapering; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 22).

Distrib. : Stem, and Pedicel.

7. Uniseriate cylindrical

Foot : Simple. Body : 3-4 celled, erect, hyaline, cylindrical, terminal cell sagittate, wide, narrowing to round end; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 23).

Distrib. : Corolla.

8. Uniseriate septate flagellate

Foot : Simple. Body : 4-7 celled, long, flagellate, tip pointed; lateral wall thin and rugose, sparsely striated; cross walls thin; lumen wide; content translucent (Fig. 24).

Distrib. : Ovary.

9. Unicellular glandular capitate

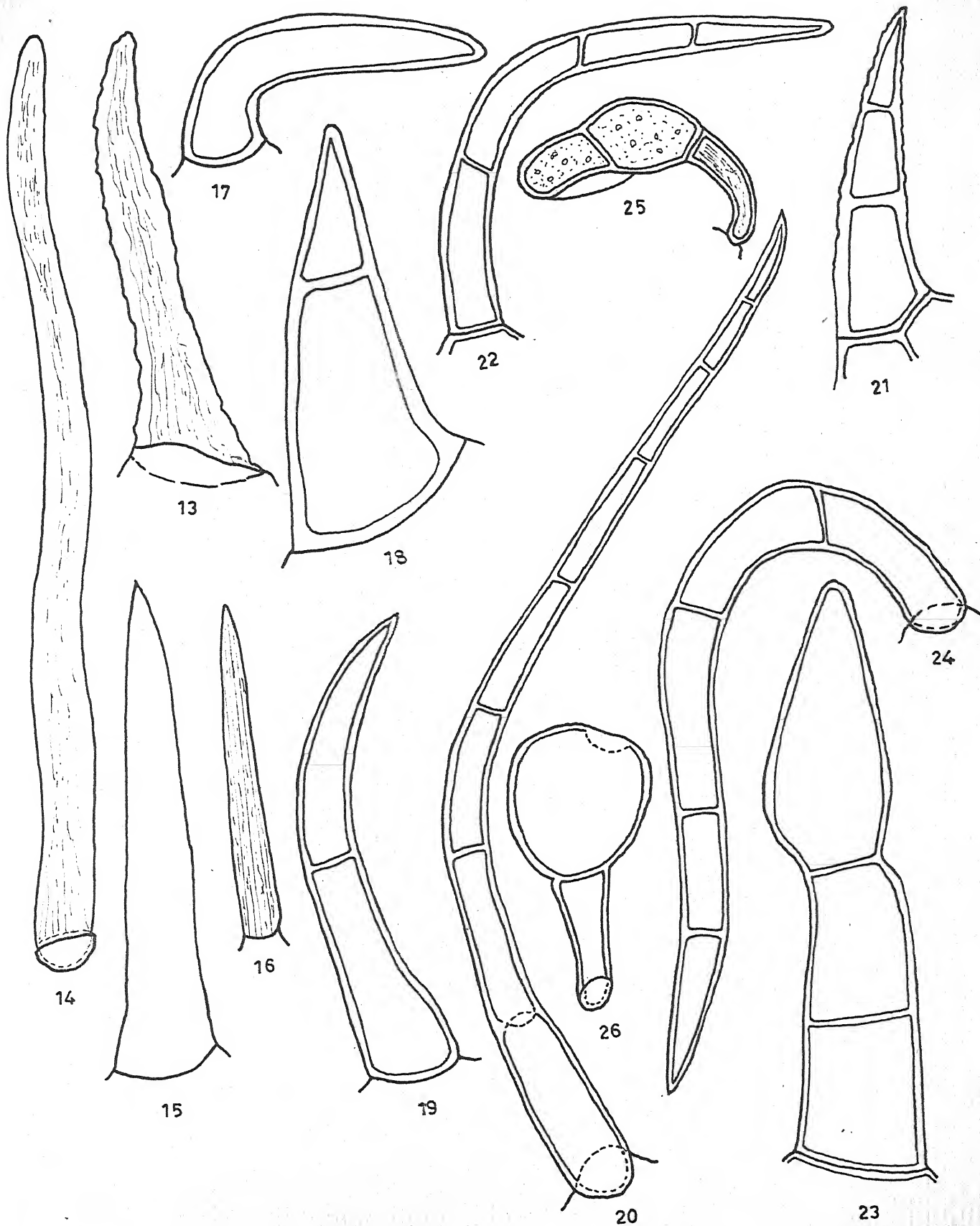
Foot : Simple. Body : Differentiated; stalk short 1-celled, erect (Fig. 26), or curved (Fig. 25); head large, globular, 1-celled (Fig. 26), or 2-celled, solenoid, with a lateral notch (Fig. 25); outer wall thin, convex, and rugose; lumen wide; content translucent (Fig. 26), or dense granulated (Fig. 25 & 26).

Distrib. : Stem, Leaf - upper surface, Calyx - lower surface, and Ovary.

EXPLANATION OF FIGURES OF PLATE - 31

Trichomes from various plant parts

- | | | |
|--------------|---|--------------------------|
| Figs. 13-16 | : | <u>Veronica agrestis</u> |
| Fig. 13 | : | Anthers filament at base |
| Fig. 14 | : | Anthers filament |
| Fig. 15 | : | Corolla upper surface |
| Fig. 16 | : | Corolla base |
| Figs. 17-26 | : | <u>Veronica persica</u> |
| Fig. 17 | : | Stem |
| Fig. 18 | : | Leaf margin |
| Figs. 19-22 | : | Stem |
| Fig. 23 | : | Corolla |
| Figs. 24, 25 | : | Ovary |
| Fig. 26 | : | Stem |



13,18,19,22,23,24,25

14,15,16,17,21

20

26

ALL 50μ

Veronica biloba

This species shows nine types of trichomes
(Plate 32; Figs. 27-36).

1. Unicellular papillose

Foot : Simple. Body : 1-celled, erect, short, papillose, tip pointed; wall thin and rugose; lumen wide; content light and granulated (Fig. 27).

Distrib. : Leaf margin.

2. Unicellular curved

Foot : Simple. Body : 1-celled, short, bent from the base to become horizontal, curved, tip round; wall thin and smooth; lumen wide; content translucent (Fig. 28).


Distrib. : Pedicel, and Corolla - upper surface.

3. Bicellular conical

Foot : Simple. Body : Entire, erect, slightly bent on one side, conical, tip pointed; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 29).

Distrib. : Leaf - along veins.

4. Bicellular curved

Foot : Simple.  Body : 2-cell long, curved, tip pointed; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 30).

Distrib. : Pedicel, Inflorescence axis, Calyx - upper surface, and Corolla.

5. Uniseriate filiform

Foot : Simple. Body : 3-5 celled, entire, erect, filiform, cells longer than broad, tip round; lateral and cross walls thin; lumen wide; content translucent (Fig. 31).

Distrib. : Stem, and Inflorescence axis.

6. Uniseriate conical

Foot : Simple. Body : 3-4 celled, entire, conical, tip pointed; lateral wall thin or thick and smooth; cross walls thin; lumen wide; content translucent or granulated (Figs. 32 & 33).

Distrib. : Calyx - lower surface & margin, and Corolla - upper surface.

7. Uniseriate curved

Foot : Simple. Body : Entire, 3-5 celled, curved, tip pointed; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 34).

Distrib. : Inflorescence axis, Pedicel, and Calyx - upper surface.

8. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled;

head very large, globular, apex cordate, 2-4 celled, cells arranged in one tier; outer wall thin and smooth; lumen of head cells much wider; content light yellowish (Fig. 35).
 Distrib. : Stem, Leaf - lower surface, Inflorescence axis, and Calyx - upper surface.

9. Uniseriate glandular capitate

Foot : Compound. Body : Differentiated; stalk long, 3-7 celled, cells longer than broad, except, short, terminal cubical collared one; head small 1-celled, globular, lateral wall thin, rugose; outer and cross walls thin and smooth; content granulated, yellowish (Fig. 36).

Distrib. : Leaf - lower surface & margin, Inflorescence axis, Pedicel, Calyx, and Corolla.

Veronica verna

This species shows five types of trichomes (Plate 32; Figs. 37-42).

1. Bicellular conical

Foot : Compound. Body : 2-celled, short, conical, upper cell short, narrowing to fine long pointed tip; outer wall thick and smooth; lumen of basal cell wider than of the apical cell; content translucent (Fig. 37).

Distrib. : Leaf - margin, Calyx tip and margin.

2. Uniseriate conical

Foot : Compound. Body : 3-5 celled, entire, erect, terminal cell short, narrowing to a fine pointed tip; lateral wall thick or thin and smooth; cross walls thick; lumen wide; narrowing towards distal end; content translucent (Fig. 38 & 39).

Distrib. : Leaf - lower surface & margin, Calyx - upper surface, Ovary, and Bract.

3. Uniseriate curved

Foot : Simple. Body : 3-5 celled, entire, curved, cells longer than broad, tip pointed; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 40).

Distrib. : Stem, and Pedicel.

4. Unicellular glandular capitate

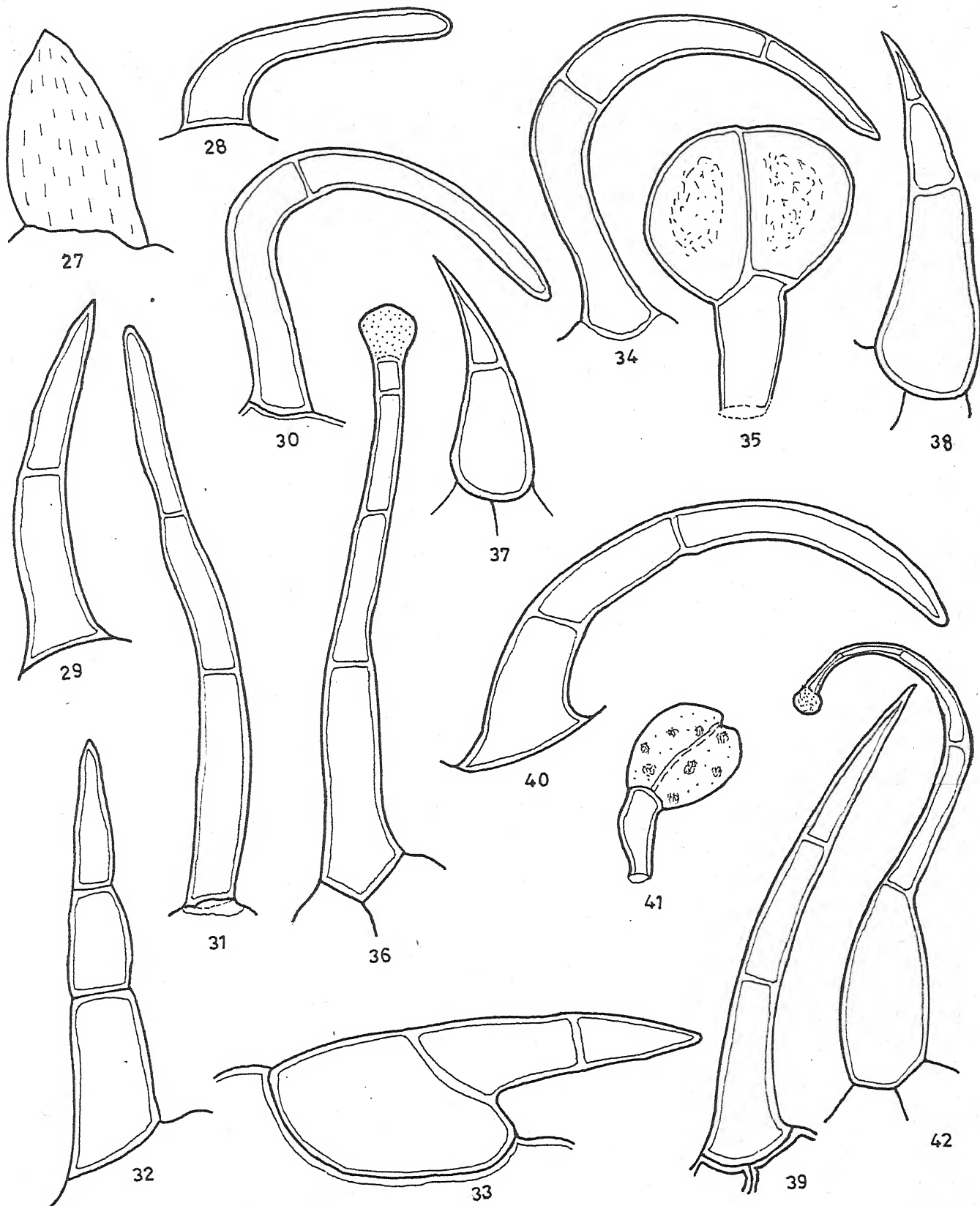
Foot : Simple. Body : Differentiated; stalk short, 1-celled, hyaline; head inflated, 2-4 celled, with an apical notch, outer wall thin and smooth; content dense with large granules (Fig. 41).

Distrib. : Stem, Leaf - upper surface, Bract, Pedicel, Calyx, and Corolla - upper surface.

EXPLANATION OF THE FIGURES OF PLATE - 32

Trichomes from various plant parts

- | | | |
|--------------|---|------------------------|
| Figs. 27-36 | : | <u>Veronica biloba</u> |
| Fig. 27 | : | Leaf margin |
| Fig. 28 | : | Flower pedicel |
| Fig. 29 | : | Leaf lower surface |
| Fig. 30 | : | Inflorescence axis |
| Fig. 31 | : | Stem |
| Fig. 32 | : | Calyx margin |
| Fig. 33 | : | Leaf margin |
| Fig. 34 | : | Inflorescence axis |
| Fig. 35 | : | Stem |
| Fig. 36 | : | Leaf margin |
| Figs. 37-42 | : | <u>Veronica verna</u> |
| Figs. 37, 38 | : | Leaf margin |
| Fig. 39 | : | Leaf lower surface |
| Figs. 40, 41 | : | Stem |
| Fig. 42 | : | Bract margin |



27,29,30,32,33,34,36,37,38,39,42

28,40

31

35,41

ALL 50μ

5. Uniseriate glandular capitate

Foot : Compound. Body : Differentiated; stalk 3-6 cell long, flexuous, basal cell pulvinate, others narrowly elongated; head very short, 1-celled, round; content bright yellow of head, and translucent that of stalk cells (Fig. 42).

Distrib. : Bract, Pedicel, and Calyx.

Veronica arvensis

This species shows seven types of trichomes (Plate 33; Figs. 43-50).

1. Bicellular conical

Foot : Compound. Body : Entire, short, conical, bent to one side as hook, terminal cell longer, narrowing to pointed tip; lateral and cross walls thick and smooth; lumen wide; content translucent (Fig. 43).

Distrib. : Calyx margin.

2. Uniseriate filiform

Foot : Simple. Body : 4-9 celled, entire, long, filiform, cells longer than broad, tip rounded, lateral wall thin and sparsely spinescent; cross walls thin; lumen narrow; content translucent (Fig. 44).

Distrib. : Stem and Pedicel.

3. Uniseriate conical

Foot : Compound. Body : 3-5 celled, entire short (Fig. 45), or long (Fig. 46), conical, tip pointed; lateral wall thick and smooth; cross walls thick or thin; lumen wide; content translucent or granulated (Figs. 45 & 46).

Distrib. : Leaf margin.

4. Uniseriate curved

Foot : Simple. Body : 4-celled, long and curved; cells longer than broad, tip round; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 47).

Distrib. : Stem and Pedicel.

5. Uniseriate septate flagellate

Foot : Simple. Body : 5-7 celled, entire, long, tubular, flagellate; lateral and cross walls thin, hyaline and smooth, lumen narrow; content translucent (Fig. 48).

Distrib. : Stem and Pedicel.

6. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk, 1-celled, oblong, erect, head 2-4 celled, large, globular, outer wall thin and smooth; content light granulated of head, and translucent that of stalk (Fig. 49).

Distrib. : Stem, Leaf, Pedicel and Calyx.

7. Uniseriate glandular capitate

Foot : Compound. Body : Differentiated; stalk, 3-5 celled, flexuous, cells longer than broad, gradually narrowing from proximal to distal end; head 1-celled, ovoid; lateral and cross walls thin and smooth; content light and granulated (Fig. 50).

Distrib. : Upper surface and margins of Bract and Calyx, Pedicel, and Ovary.

Veronica serpyllifolia

This species shows eight types of trichomes (Plate 33, 34; Figs. 51-60).

1. Unicellular papillose

Foot : Simple. Body : Entire, hyaline, papillose, tip rounded; wall thin and smooth; lumen wide; content light and granulated (Fig. 51).

Distrib. : Stem, and Style.

2. Uniseriate filiform

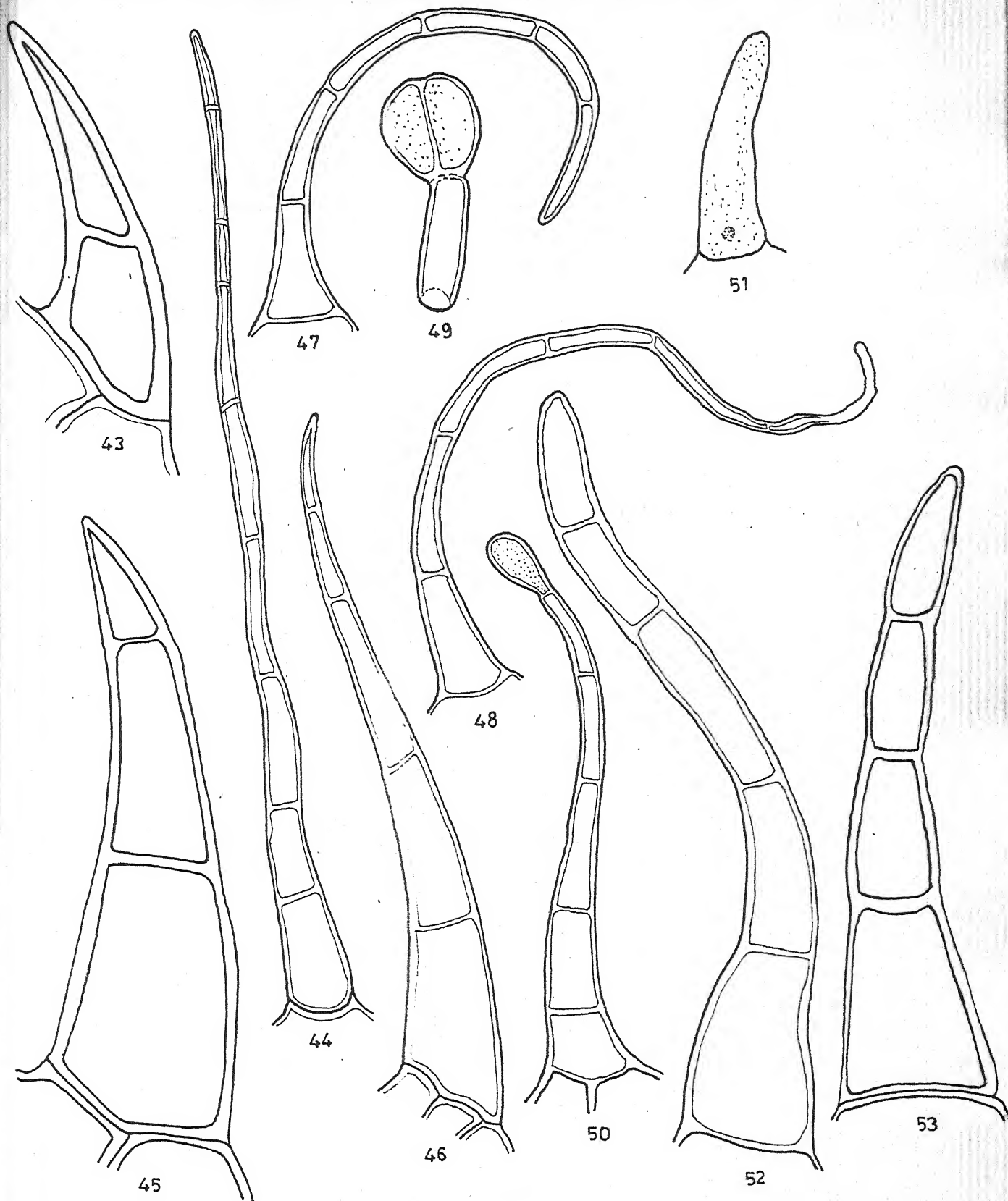
Foot : Simple. Body : Entire, 4-7 celled, filiform, cells longer than broad, tip round; lateral and cross walls thin and smooth; lumen wide; content dense (Fig. 52).

Distrib. : Pedicel, and Calyx - upper surface.

EXPLANATION OF THE FIGURES OF PLATE - 33

Trichomes from various plant parts

- | | | |
|-------------|---|-------------------------------|
| Figs. 43-50 | : | <u>Veronica arvensis</u> |
| Fig. 43 | : | Calyx margin |
| Fig. 44 | : | Stem |
| Fig. 45 | : | Leaf margin |
| Fig. 46 | : | Leaf lower surface |
| Fig. 47 | : | Stem |
| Fig. 48 | : | Flower pedicel |
| Fig. 49 | : | Stem |
| Fig. 50 | : | Calyx upper margin |
| Figs. 51-53 | : | <u>Veronica serpyllifolia</u> |
| Fig. 51 | : | Style |
| Fig. 52 | : | Calyx upper surface |
| Fig. 53 | : | Calyx lower " |



43,45,51,52,53

47,48,50

44,46

49

ALL 50 μ

3. Uniseriate conical

Foot : Simple. Body : Entire, 4-6 celled, stiff, erect, conical, tip round; lateral wall thick, smooth and constricted at joints; cross walls thick; lumen wide; content translucent (Fig. 53).

Distrib. : Calyx - lower surface.

4. Uniseriate cylindrical

Foot : Simple. Body : Entire, 3-5 celled, broad, cylindrical, slightly curved, tip round; lateral wall thin and smooth, with articulation at joint of basal cell; cross walls thin; lumen wide; content translucent, granulated and collapsing, nucleus persistent in some cells (Figs. 54 & 55).

Distrib. : Leaf - upper surface, and Pedicel.

5. Uniseriate curved

Foot : Simple. Body : Entire, 3-5 celled, decurved, cells longer than broad, tip round; lateral and cross walls thin and smooth; lumen wide; content light and granulated (Fig. 56).

Distrib. : Stem, Leaf - upper surface, and Pedicel.

6. Uniseriate septate flagellate

Foot : Simple. Body : Entire, flagellate, basal cell broader than others, cells longer than broad, tip round; lateral and cross walls thin and smooth; content translucent (Fig. 57).

Distrib. : Stem, and Leaf - upper surface.

7. Unicellular glandular capitate

Foot : Simple. Body : Long, cylindrical, differentiated; stalk 1-celled, short or very long and broad, cylindrical; head 1-celled; oblong, fitted on stalk or 2-4 celled, inflated; cells large; outer wall thin, smooth or rugose; lateral wall thin and smooth; content translucent, or dense, granulated (Fig. 58 & 59).

Distrib. : Stem, Leaf, Bract, and Calyx.

8. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-4 celled, cells longer than broad; head 1-celled, short, oval and glandular, outer and lateral walls thin and smooth; cross walls thin; lumen wide; content light and granulated of head, translucent that of stalk (Fig. 60).

Distrib. : Stem, Leaf - upper surface, Bract - upper surface & margin, Calyx, and Corolla - upper surface.

Veronica undulata

This species shows two types of trichomes (Plate 34; Figs. 61 & 62).

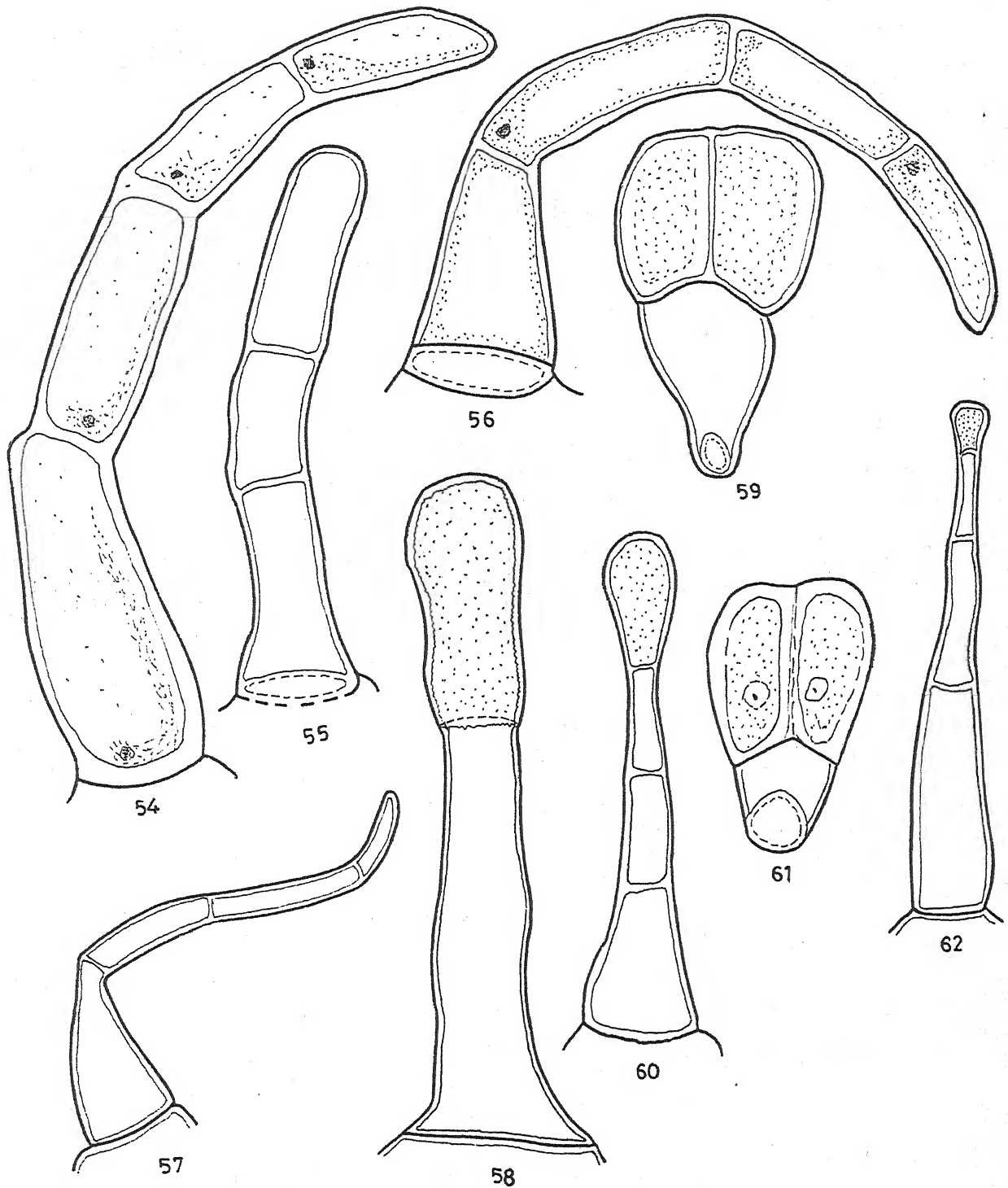
1. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head large, 2-4 celled, auriculate, apex cordate; cells arranged in one tier; outer wall thin, convex and smooth;

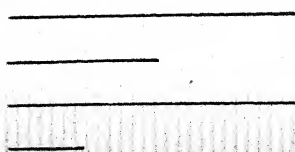
EXPLANATION OF THE FIGURES OF PLATE - 34

Trichomes from various plant parts

- | | | |
|-------------|---|-------------------------------|
| Figs. 54-60 | : | <u>Veronica serpyllifolia</u> |
| Fig. 54 | : | Leaf base |
| Fig. 55 | : | Flower pedicel |
| Fig. 56 | : | Stem |
| Fig. 57 | : | Leaf upper surface |
| Fig. 58 | : | Bract margin |
| Fig. 59 | : | Stem |
| Fig. 60 | : | Calyx |
| Figs. 61-62 | : | <u>Veronica undulata</u> |
| Fig. 61 | : | Calyx upper surface |
| Fig. 62 | : | Stem |



54, 55, 56, 58
57, 60
59, 61
62



ALL 50μ

lumen wide; content of head dense, nucleated and granulated, translucent that of stalk (Fig. 61).

Distrib. : Leaf - lower surface, and Calyx - upper surface.

2. Uniseriate glandular capitate

Foot : Simple or compound. Body : Differentiated; stalk 3-5 celled, basal cell pulvinate, cells longer than broad, gradually narrowing and shortening towards distal end; head 1-celled, oval, glandular; lateral wall thin and smooth; lumen narrow except basal cell; content dark and granulated of head, translucent that of stalk cells (Fig. 62).

Distrib. : Stem, Leaf, Inflorescence axis, Pedicel, Calyx, Corolla, and Ovary.

Veronica eriocarpa

This species shows four types of trichomes (Plate 35; Figs. 63-67).

1. Uniseriate filiform

Foot : Compound or simple. Body : Entire, 5-12 celled, filiform, stiff, erect or undulated, cells longer than broad, tip round; lateral wall thin or thick, straight or convex, smooth (Fig. 63) or rugose (Fig. 64); cross walls thin; lumen wide; content translucent (Fig. 63) or light, granulated and vacuolated (Figs. 63 & 64).

Distrib. : Leaf, Bract, Calyx margin, and Ovary.

2. Uniseriate conical

Foot : Compound. Body : Entire, 3-4 celled, conical, cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 65).

Distrib. : Leaf margin.

3. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 6-10 celled, long, tubular, flagellate, cells longer than broad, tip pointed; lateral wall thin, slightly convex and smooth; cross walls thin; lumen narrow; content translucent (Fig. 66).

Distrib. : Stem.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short, upper part broader; head inflated, 2-4 celled, arranged in one tier, outer wall thin and smooth; lumen wide; content dark of stalk, light and granulated of head (Fig. 67).

Distrib. : Bract, and Calyx.

Veronica mellissaeifolia

This species shows five types of trichomes
(Plate 35; Figs. 68-72).

1. Unicellular papillose

Foot : Not visible. Body : Entire, fusiform, papillose,

tip pointed; wall thin, hyaline and smooth; lumen wide; content translucent (Fig. 68).

Distrib. : Corolla - lower surface.

2. Uniseriate filiform

Foot : Simple or compound. Entire 5-15 celled, cells longer than broad, tip pointed; lateral wall thin and rugose; lumen wide; narrowing towards distal end; content translucent (Fig. 69).

Distrib. : Stem, Leaf, Bract margin, Calyx margin, and Ovary.

3. Uniseriate curved

Foot : Compound. Body : Entire, 7-11 celled, curved; cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 70).

Distrib. : Calyx.

4. Uniseriate septate flagellate

Foot : Simple. Body : Entire, long, 6-8 celled, flagellate, cells longer than broad, tip pointed; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 71).

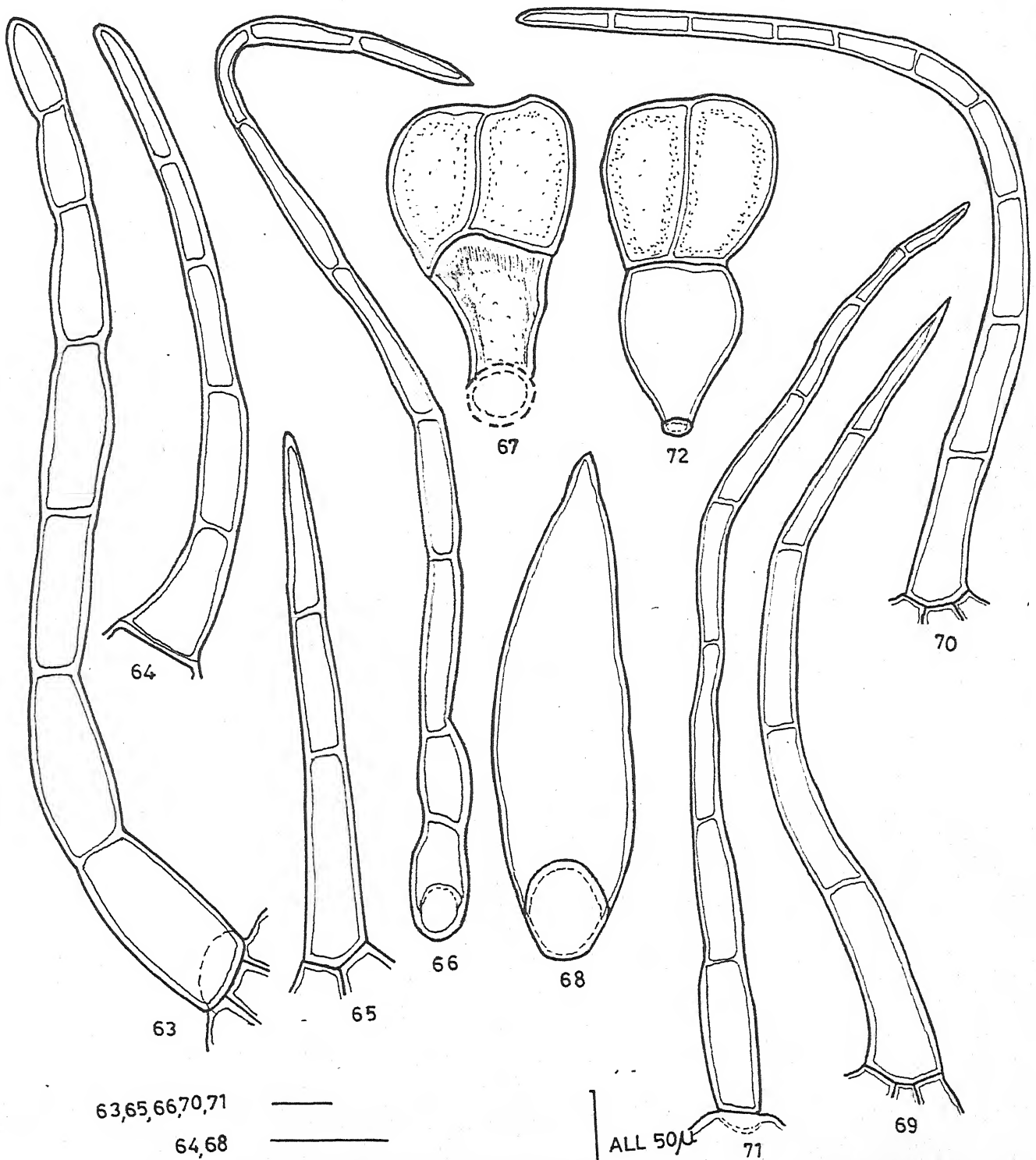
Distrib. : Stem.

EXPLANATION OF THE FIGURES OF PLATE - 35

Trichomes from various plant parts

- | | | |
|-------------|---|-------------------------------|
| Figs. 63-67 | : | <u>Veronica eriocarpa</u> |
| Fig. 63 | : | Leaf upper surface |
| Fig. 64 | : | Ovary |
| Fig. 65 | : | Leaf margin |
| Fig. 66 | : | Stem |
| Fig. 67 | : | Bract |
| | | |
| Figs. 68-72 | : | <u>Veronica mellisaefolia</u> |
| Fig. 68 | : | Corolla lower surface |
| Fig. 69 | : | Leaf margin |
| Fig. 70 | : | Stem |
| Fig. 71 | : | Calyx |
| Fig. 72 | : | Stem |

PLATE-35



63,65,66,70,71

64,68

67,72

69

ALL 50μ

5. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short, upper part broader; head large, 2-4 celled, cells arranged in one tier; outer wall thin, convex and smooth; lumen wide; content light and granulated (Fig. 72).

Distrib. : Stem, Leaf and Bract.

Digitalis purpurea

This species shows five types of trichomes (Plate 36; Figs. 73-77).

1. Unicellular clavate

Foot : Not visible. Body : Entire, tip swollen, club-shaped; walls thin, hyaline and smooth; lumen wide; content translucent (Fig. 73).

Distrib. : Corolla - lower surface, at the point of attachment of Anther filaments.

2. Uniseriate filiform

Foot : Simple. Body : Entire, 5-8 celled, filiform; cells longer than broad, base of lower cell provided with vertical striations, tip round; lateral and cross walls thin and smooth; lumen narrow; content light yellowish (Fig. 74).

Distrib. : Calyx, and Stigma.

3. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 2-celled, cells longer than broad; head large, 2-celled, elongated, glandular cells directly seated on the terminal cells of stalk; outer wall thin, convex and smooth; lateral wall thin and smooth; lumen wide; content bright granulated yellowish of head, translucent that of stalk (Fig. 75).

Distrib. : Leaf - upper surface.

4. Uniseriate glandular

Foot : Simple. Body : 6-8 celled, cylindrical, cells almost rectangular, terminal cell swollen and glandular; lateral and cross walls thin and smooth; lumen wide; content translucent, light yellowish and granulated of terminal cell (Fig. 76).

Distrib. : Anther filaments - upper part.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk very long, 4-10 celled, or short, cells longer than broad, head oval or oblong, multicellular, with dark striations, cells arranged vertically in one tier; lateral and outer walls thin and smooth; lumen wide; content yellowish, dense of head, translucent that of stalk cells (Fig. 77).

Distrib. Bract, Calyx, Corolla, Style, Stigma, and Ovary.

Digitalis lanata

This species shows five types of trichomes
(Plate 36; Figs. 78-82).

1. Uniseriate filiform

Foot : Simple. Body : Entire, 6-12 celled, very long, cells longer than broad, tip round; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 78).

Distrib. : Stem, Leaf - mid rib and margin.

2. Uniseriate cylindrical

Foot : Simple. Body : Entire, 5-7 celled, cylindrical, cells almost rectangular, except the terminal one, tip round; lateral wall thin, convex, smooth and constricted at joints; cross walls thin; lumen wide; content translucent (Fig. 79).

Distrib. : Pedicel, and Calyx base.

3. Uniseriate hooked

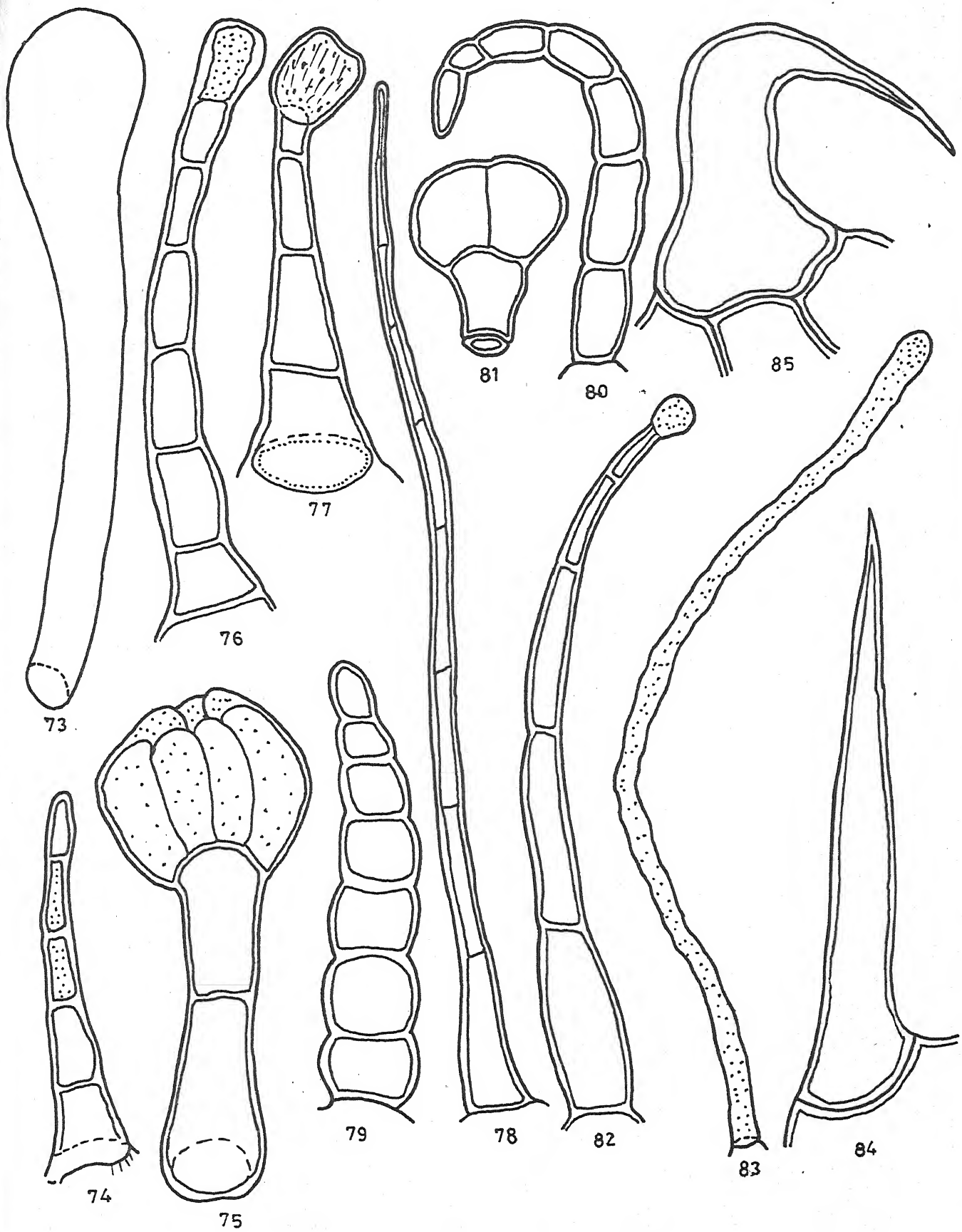
Foot : Simple. Body : Entire, 6-8 celled, hooked, cells longer than broad, apical few cells incurved, tip pointed, facing downward; lateral wall thin, convex, smooth and constricted at joints; cross walls thin; lumen wide; content translucent (Fig. 80).

Distrib. : Pedicel.

EXPLANATION OF THE FIGURES OF PLATE - 36

Trichomes from various plant parts

- | | |
|-------------|---------------------------------|
| Figs. 73-77 | : <u>Digitalis purpurea</u> |
| Fig. 73 | : Base of anther filament |
| Fig. 74 | : Stigma |
| Fig. 75 | : Leaf upper surface |
| Fig. 76 | : Upper part of anther filament |
| Fig. 77 | : Calyx upper surface |
| Figs. 78-82 | : <u>Digitalis lanata</u> |
| Fig. 78 | : Stem |
| Figs. 79-81 | : Flower pedicel |
| Fig. 82 | : Calyx margin |
| Figs. 83-85 | : <u>Alectra indica</u> |
| Fig. 83 | : Corolla lower surface |
| Fig. 84 | : Bract margin |
| Fig. 85 | : Leaf margin |



73, 75, 78, 82, 83 ———
 74, 77, 80 ———
 76, 79, 81, 84, 85 ———

ALL 50 μ

4. Unicellular glandular capitate

Foot : Not visible. Body : Differentiated; stalk short, 1-celled; head large, 2-4 celled, cells arranged in one tier; outer wall thin and smooth; lumen wide; content dark granulated (Fig. 81).

Distrib. : Pedicel.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk, 3-10 celled, cells longer than broad; head 1-celled, round, glandular; outer wall thin; lateral and cross walls thin and smooth; content translucent of stalk, and granulated of head (Fig. 82).

Distrib. : Stem, Leaf - upper surface, & margin, Pedicel, Calyx, and Ovary.

Alcea indica

This species shows nine types of trichomes (Plates 36 & 37; Figs. 83-91).

1. Unicellular flagellate

Foot : Not visible. Body : 1-celled, very long, narrow, tubular, flexuous, tip round; wall thin and uneven; lumen varied; content dark and granulated (Fig. 83).

Distrib. : Corolla - lower surface, at the point of attachment of Anther filaments.

2. Unicellular conical

Foot : Simple. Body : Entire, erect conical, gradually tapering to a pointed tip; wall thick and smooth; lumen wide; content translucent (Fig. 84).

Distrib. : Bract - upper surface and margin.

3. Unicellular hooked

Foot : Compound. Body : Entire, distal part sharply curved to form anchor, tip long, fine pointed; wall thick and smooth; lumen wide; content translucent (Fig. 85).

Distrib. : Leaf margin.

4. Bicellular filiform

Foot : Compound. Body : Entire, straight, filiform, upper cell much longer than the lower one, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 86).

Distrib. : Stem.

5. Bicellular conical

Foot : Simple or compound. Body : Entire, erect, lower cell short and broad than the upper longer one, tip pointed; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 87).

Distrib. : Bract, and Calyx.

6. Bicellular curved

Foot : Simple. Body : Entire, curved at the septum; upper cell long and narrow, lower cell short and straight, tip pointed; lateral wall thick and smooth; cross walls thin; lumen wide; content translucent (Fig. 88).

Distrib. : Leaf - upper surface and along mid rib.

7. Uniseriate curved

Foot : Compound. Body : 3-celled, articulated, curved, cells long and narrow, tip pointed; lateral wall thin, smooth, and constricted at joints; cross walls thin; lumen narrow; content translucent (Fig. 89).

Distrib. : Calyx margin.

8. Uniseriate septate flagellate

Foot : Compound. Body : 3-celled, very long, flagellate, cells much longer than broad, tip pointed; lateral wall thin, smooth, and constricted at joints; cross walls thin; lumen narrow; content translucent (Fig. 90).

Distrib. : Stem, Bract, Calyx - upper surface and margin.

9. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk, short, 1-celled; head large, multicellular, globular; cells large, hyaline, arranged in a rosette form, directly on the stalk cells;

EXPLANATION OF THE FIGURES OF PLATE - 37

Trichomes from various plant parts

Figs. 86-91 : Alectra indica

Fig. 86 : Stem

Fig. 87 : Bract upper surface

Fig. 88 : Leaf upper "

Fig. 89 : Calyx margin

Fig. 90 : Stem

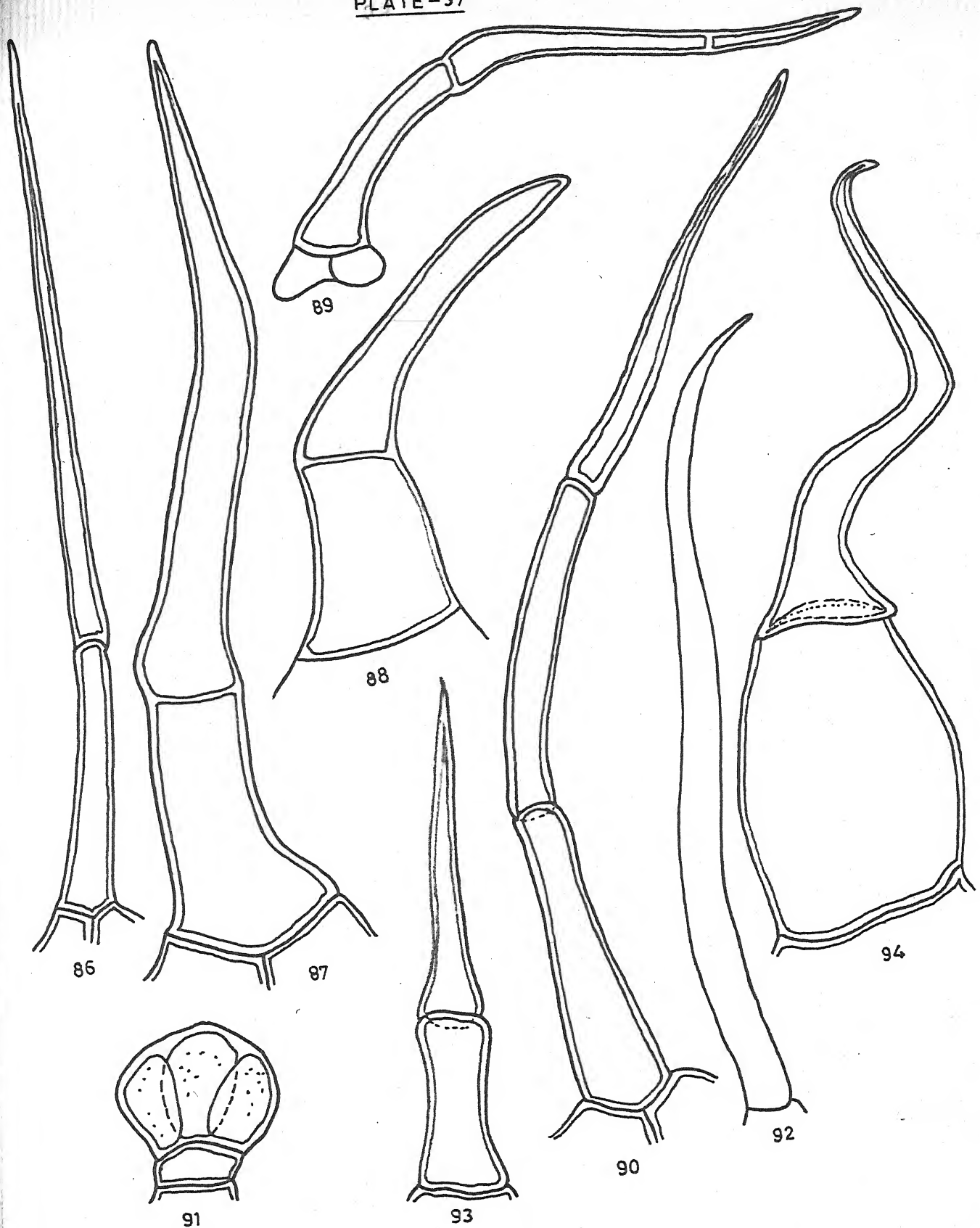
Fig. 91 : Calyx

Figs. 92-94 : Alectra parasitica var. chitrakutenalis

Fig. 92 : Stem

Fig. 93 : Leaf margin

Fig. 94 : Bracteole margin



86, 90 _____
 87, 88, 92, 94 _____
 89, 93 _____
 91 _____

ALL 50/μ

outer wall thin, hyaline, and smooth; markings of wall overlapping; content translucent of head, and dark that of stalk (Fig. 91).

Distrib. : Leaf - upper surface, Bract, Calyx and Corolla - lower surface.

Alectra parasitica var. chitrakutensis

This species shows five types of trichomes (Plates 37 & 38; Figs. 92-97).

1. Unicellular acuminate

Foot : Simple. Body : 1-celled, entire, erect, acuminate, tip pointed; wall thin and smooth; lumen wide, becoming narrow towards the tip; content translucent (Fig. 92).

Distrib. : Stem, and Bracteole - margin.

2. Bicellular acuminate

Foot : Simple. Body : 2-celled, differentiated, upper cell long and narrower than the lower one; tip pointed; lateral wall thin, smooth and constricted at joints; lumen wide in lower cell but narrow in upper one; content translucent (Fig. 93).

Distrib. : Leaf margin.

3. Bicellular aseptate flagellate

Foot : Simple. Body : Differentiated, upper cell long, narrow and flagellate, lower cell broad, barrel-shaped; tip pointed; lateral wall thin and smooth; lumen wide except in distal part; content translucent (Fig. 94).

Distrib. : Stem, Leaf- upper surface and margin, Bract, and Calyx margin.

4. Uniseriate aseptate flagellate

Foot : Simple. Body : Entire, 3-4 celled, flagellate, cells longer than broad, tip pointed; lateral wall and cross walls thin and smooth; lumen wide or narrow; content translucent (Fig. 95).

Distrib. : Bract, and Calyx margin.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-4 celled, erect, cells rectangular or barrel-shaped; head globular, 2-4 celled (Fig. 96) or large, irregularly inflated, multicellular (Fig. 97); outer wall thin, smooth or uneven; lateral wall thin, smooth, and constricted at joints; cross walls thin; lumen wide; content translucent (Figs. 96 & 97).

Distrib. : Corolla - lower surface, and margin.

Alectra sessiliflora

This species shows five types of trichomes
(Plate 38; Figs. 98-103).

1. **Unicellular flagellate**

Foot : Not visible. Body : 1-celled, very long, flagellate, tip round and verrucose; wall thin, rugose and uneven; lumen wide; content granulated, translucent (Fig. 98).
Distrib. : Anther filaments distal part (2 Anther filaments without trichomes).

2. **Bicellular sepectate flagellate**

Foot : Compound. Body : 2-celled, differentiated; lower cell short, erect and broad, upper cell long, flagellate, tip pointed; lateral wall thin and smooth; lumen wide; content dense, granulated and collapsing (Fig. 99).
Distrib. : Calyx margin.

3. **Uniseriate filiform**

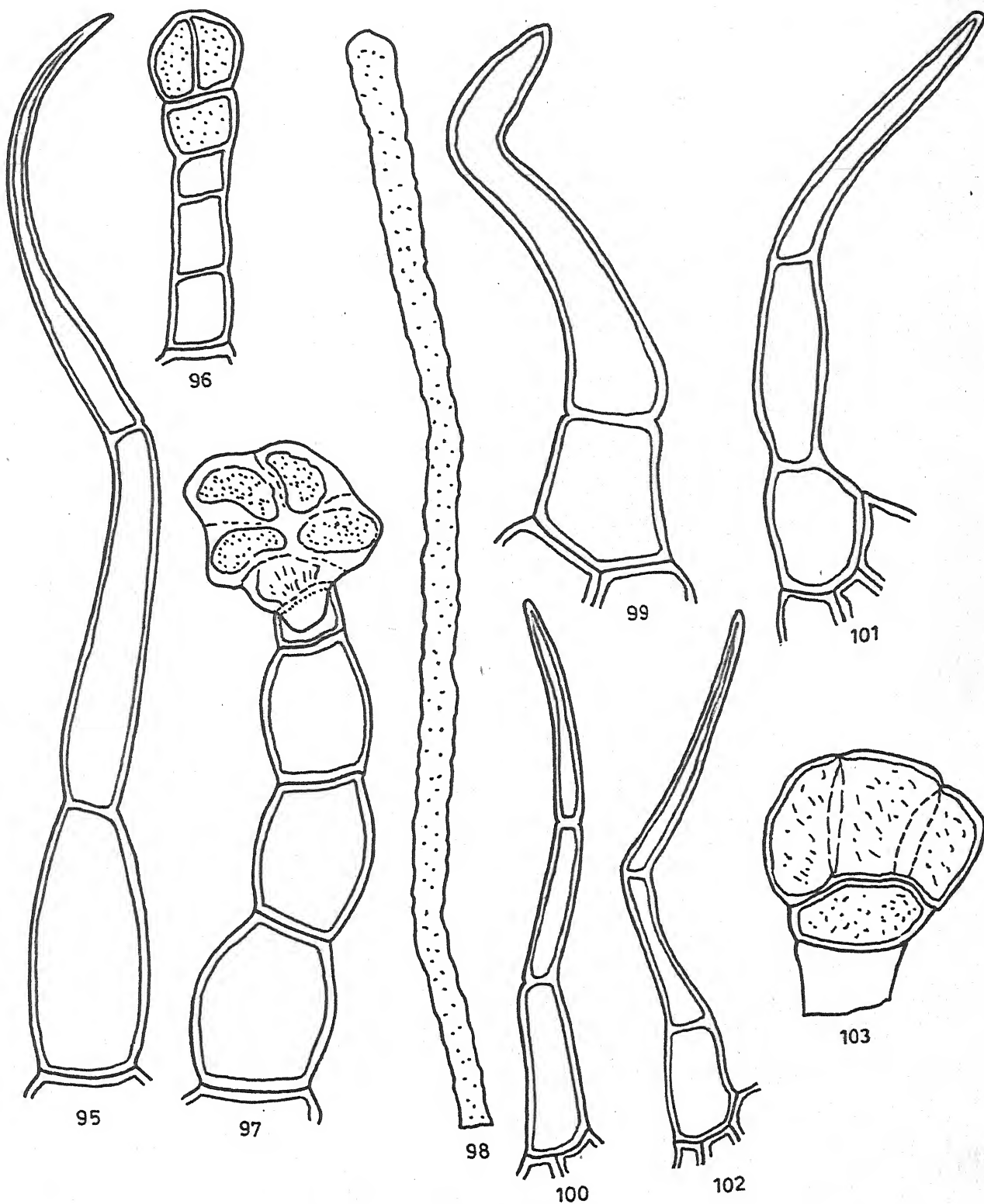
Foot : Compound. Body : Entire, 3-5 celled, filiform, cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 100).

Distrib. : Calyx.

EXPLANATION OF THE FIGURES OF PLATE - 38

Trichomes from various plant parts

- Figs. 95-97 : Alectra parasitica var. chitrakutensis
Fig. 95 : Bracteole margin
Fig. 96 : Corolla lower surface
Fig. 97 : Corolla margin
- Figs. 98-103 : Alectra sessiliflora
Fig. 98 : Anther filament
Fig. 99 : Calyx margin
Fig. 100 : Calyx lower surface
Fig. 101 : Bracteole
Fig. 102 : Calyx margin
Fig. 103 : Calyx upper surface



95,96,97,99

98,100,102

101

103

ALL 50 μ

4. Uniseriate curved

Foot : Compound. Body : 3-celled, curved, cells of various shape, terminal cell longest; lateral wall thin, slightly convex and smooth; cross walls thin; content granulated, translucent (Figs. 101 & 102).

Distrib. : Bractiole.

5. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head large, multicellular; cells arranged like a rosette; outer wall thin, convex and smooth; content dark of head cells, and translucent that of stalk (Fig. 103).

Distrib. : Bractiole, Calyx - upper surface, Corolla, and Style.

Eugenia hispida

This species shows four types of trichomes (Plate 39; Figs. 104-107).

1. Unicellular hooked

Foot : Simple. Body : Entire, narrowing to pointed tip, facing downward; wall thick and smooth; lumen wide at base, sharply narrowing above; content dark (Fig. 104).

Distrib. : Stem, and Calyx margin.

2. Bicellular asseptate flagellate

Foot : Simple or compound. Body : 2-celled, differentiated, lower cell short and erect, upper cell much longer, narrow, flagellate; tip pointed; lateral wall thin and smooth; lumen varied; content translucent (Fig. 105).

Distrib. : Stem, Leaf - lower surface & margin, and Calyx.

3. Uniseriate filiform

Foot : Compound. Body : 3-celled, long filiform, cells much longer than broad, tip pointed; lateral wall thin and rugose; lumen narrow; content translucent (Fig. 106).

Distrib. : Stem.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk very short, discoid, 1-celled, broader than length; head large, globular, 2-4 celled; outer wall thin and smooth; content translucent of head cells and granulated that of stalk (Fig. 107).

Distrib. : Leaf.

Striga orobanchoides

This species shows six types of trichomes
(Plate 39; Figs. 108-115).

1. Unicellular papillose

Foot : Not visible. Body : 1-celled, small tubular, papillose; surface warty; wall thin and hyaline; lumen varied;

content translucent (Fig. 108).

Distrib. : Corolla - upper surface.

2. Unicellular flagellate

Foot : Compound. Body : Entire, long, flagellate, tip pointed; wall thin and rugose; lumen wide; content translucent (Fig. 109).

Distrib. : Stem and Corolla - upper surface.

3. Unicellular conical

Foot : Compound. Body : Entire, conical, gradually tapering to a pointed tip; wall thick and rugose; lumen narrow (Fig. 110) or wide (Fig. 111); content dense yellow or opaque (Figs. 110 & 111).

Distrib. : Stem, Leaf - upper surface along mid rib and margin, Bract, Calyx, and Corolla.

4. Bicellular aseptate flagellate

Foot : Compound. Body : Differentiated, distal part flagellate, lower cell small, cubical, upper cell very long, stiff (Fig. 112) or loosely flagellate (Fig. 113); lateral wall thin and rugose; content translucent or dense yellowish (Figs. 112 & 113).

Distrib. : Stem, Leaf - upper surface & margin and Bract.

EXPLANATION OF THE FIGURES OF PLATE - 39

Trichomes from various plant parts

Figs. 104-107 : Buchnera hispida

Fig. 104 : Stem

Fig. 105 : Leaf lower surface

Fig. 106 : Stem

Fig. 107 : Leaf

Figs. 108-115 : Striga orobanchoides

Fig. 108 : Corolla upper surface

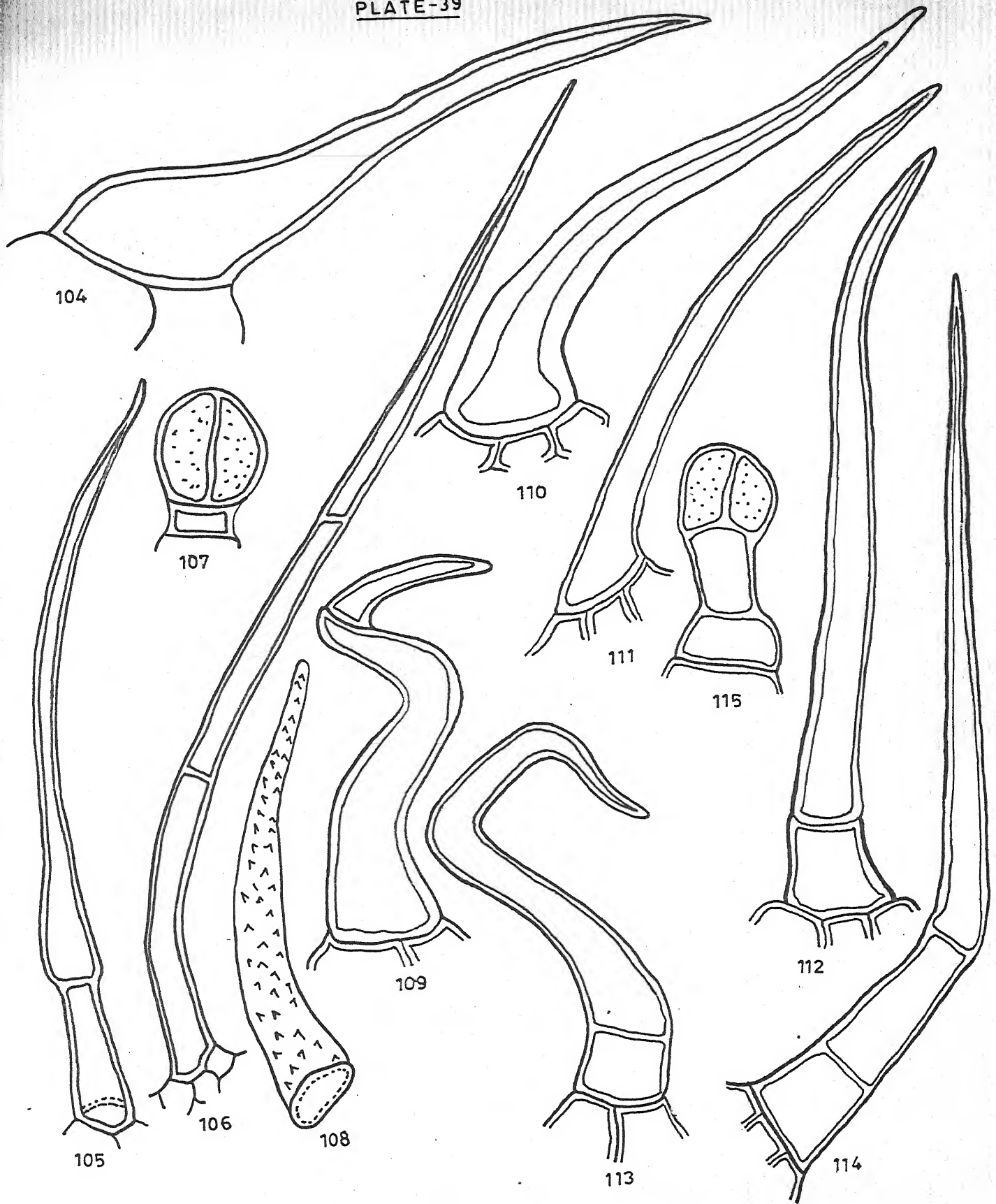
Fig. 109 : Stem

Fig. 110 : Leaf upper surface

Fig. 111 : Leaf margin

Figs. 112-114 : Stem

Fig. 115 : Corolla upper surface



104, 105, 107, 115

106

108, 111, 112, 113, 114

109, 110

ALL 50μ

5. Uniseriate acuminate

Foot : Compound. Body : 3-celled, entire, lower two cells small erect; terminal cell very long, straight, bent on one side, gradually narrowing to a pointed tip; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 114).

Distrib. : Stem.

6. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short 2-celled, lower cell short and broader than upper one; head 2-4 celled, oblong, cells arranged in one tier; outer wall thin and smooth; content of head granulated, light yellow, and translucent that of stalk cells (Fig. 115).

Distrib. : Stem, Leaf - lower surface, Calyx, and Corolla - upper surface.

Striga lutea

This species shows four types of trichomes (Plate 40; Figs. 116-119).

1. Unicellular papillose

Foot : Not visible. Body : Entire, short, hyaline, wall thin and smooth; lumen wide; content translucent (Fig. 116).

Distrib. : Corolla - lower surface.

2. Unicellular flagellate

Foot : Compound. Body : 1-celled, long or short, flagellating to a fine narrow pointed tip; wall thin and smooth; lumen narrow; content translucent (Fig. 117).

Distrib. : Stem, Leaf, Inflorescence axis, and Calyx tips.

3. Unicellular acuminate

Foot : Simple. Body : Entire, erect, having a long slender sharp point, wall thin and smooth; lumen narrow; content translucent (Fig. 118).

Distrib. : Corolla - lower surface and Anther - base of the filaments.

4. Uniseriate conical

Foot : Compound. Body : 3-celled, entire, slightly curved, conical, terminal cell long, narrow, cells longer than broad, swollen and articulated; tip pointed; lateral wall thick, smooth or slightly concave or convex; cross wall thick, incomplete, forming inter-cellular passage; lumen wide; content translucent or opaque (Fig. 119).

Distrib. : Calyx margin.

Striga euphrasiioides

This species shows eight types of trichomes
(Plate 40; Figs. 120-127).

1. Unicellular flagellate

Foot : Simple. Body : 1-celled, long, hyaline, flagellate, tip round; lumen wide; gradually becoming narrower towards tip; content translucent (Fig. 120).

Distrib. : Corolla - lower surface, Anther - base of the filament.

2. Unicellular conical

Foot : Seems to be compound. Body : Entire, short, conical, tapering to pointed tip; wall thin and smooth; lumen wide; content translucent (Fig. 121).

Distrib. : Stem, Leaf, Bract, Bracteole, and Calyx.

3. Unicellular hooked

Foot : Simple. Body : Entire, stiffly hooked, narrowing to pointed tip; wall thick and rugose; lumen wide at base; content translucent (Fig. 122).

Distrib. : Stem, Leaf, Bract, and Calyx - upper surface & margin.

4. Bicellular cylindrical

Foot : Simple. Body : Entire, erect, cylindrical; upper cell long, tip round; lateral wall thick, rugose, constricted at joints; cross walls thick; lumen wide; content translucent (Fig. 123).

Distrib. : Corolla.

5. Bicellular hooked

Foot : Simple. Body : Entire, hooked; lower cell longer than upper, short, geniculate cell; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 124).

Distrib. : Bract.

6. Bicellular aseptate flagellate

Foot : Simple. Body : Differentiated; lower cell short and broad, upper cell very long, slender and flagellate; lateral wall thin and smooth, cross wall thick; lumen wide; content translucent (Fig. 125).

Distrib. : Anther filaments at base.

7. Peltate glandular

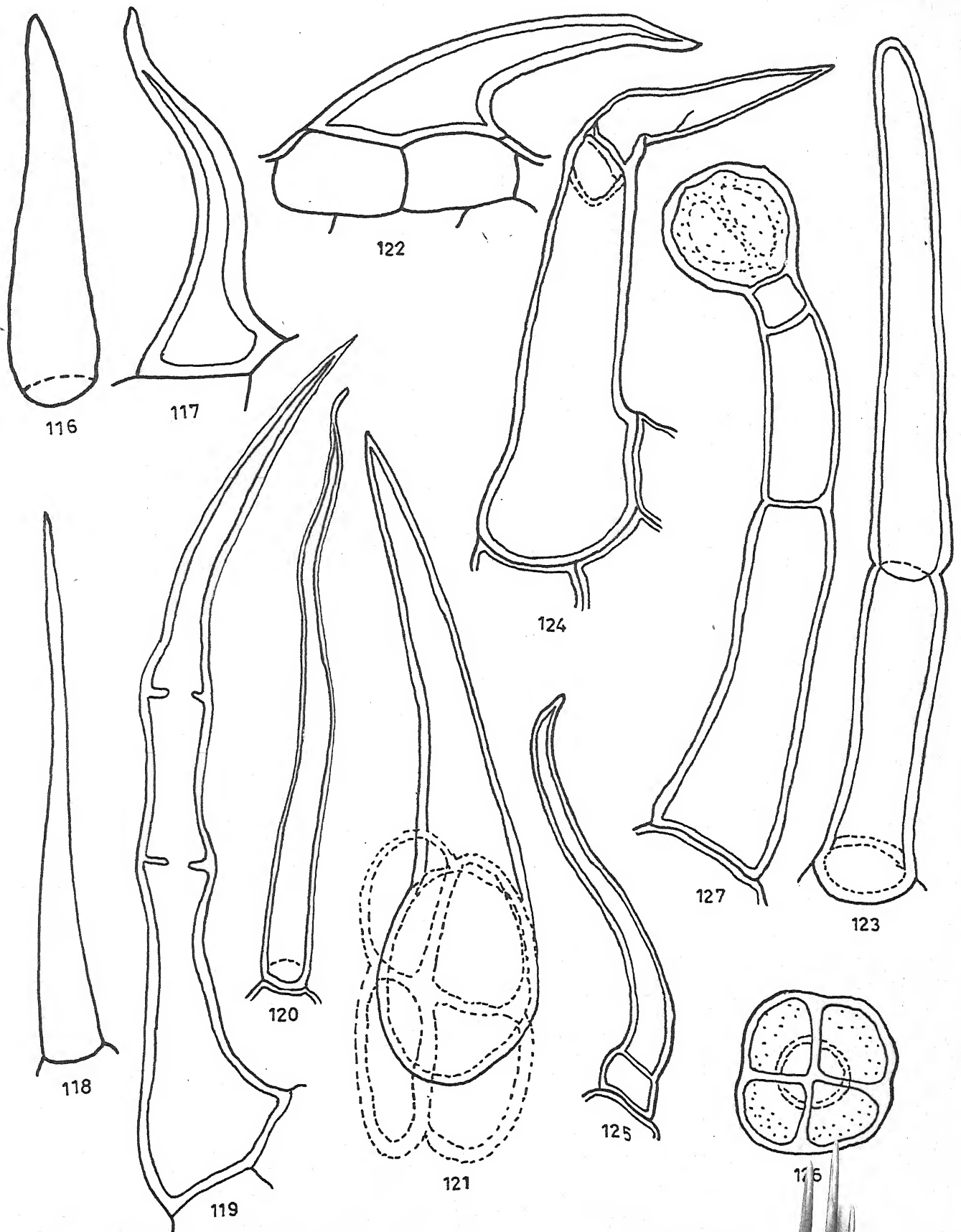
Foot : Not visible except marking. Body : Peltate, sessile, multicellular, shield-like, 1-cell thick; cells arranged cruciately; outer wall thin, convex and smooth; content granulated & translucent (Fig. 126).

Distrib. : Leaf, Bract, and Calyx - lower surface.

EXPLANATION OF THE FIGURES OF PLATE - 40

Trichomes from various plant parts

- Figs. 116-119 : Striga lutea
- Fig. 116 : Corolla lower surface
- Fig. 117 : Inflorescence axis
- Fig. 118 : Anther filament
- Fig. 119 : Calyx margin
- Figs. 120-127 : Striga euphrasioides
- Fig. 120 : Base of anther filament
- Fig. 121 : Stem
- Fig. 122 : Calyx margin
- Fig. 123 : Corolla lower surface
- Fig. 124 : Bract
- Fig. 125 : Anther filament
- Fig. 126 : Leaf
- Fig. 127 : Corolla lower surface

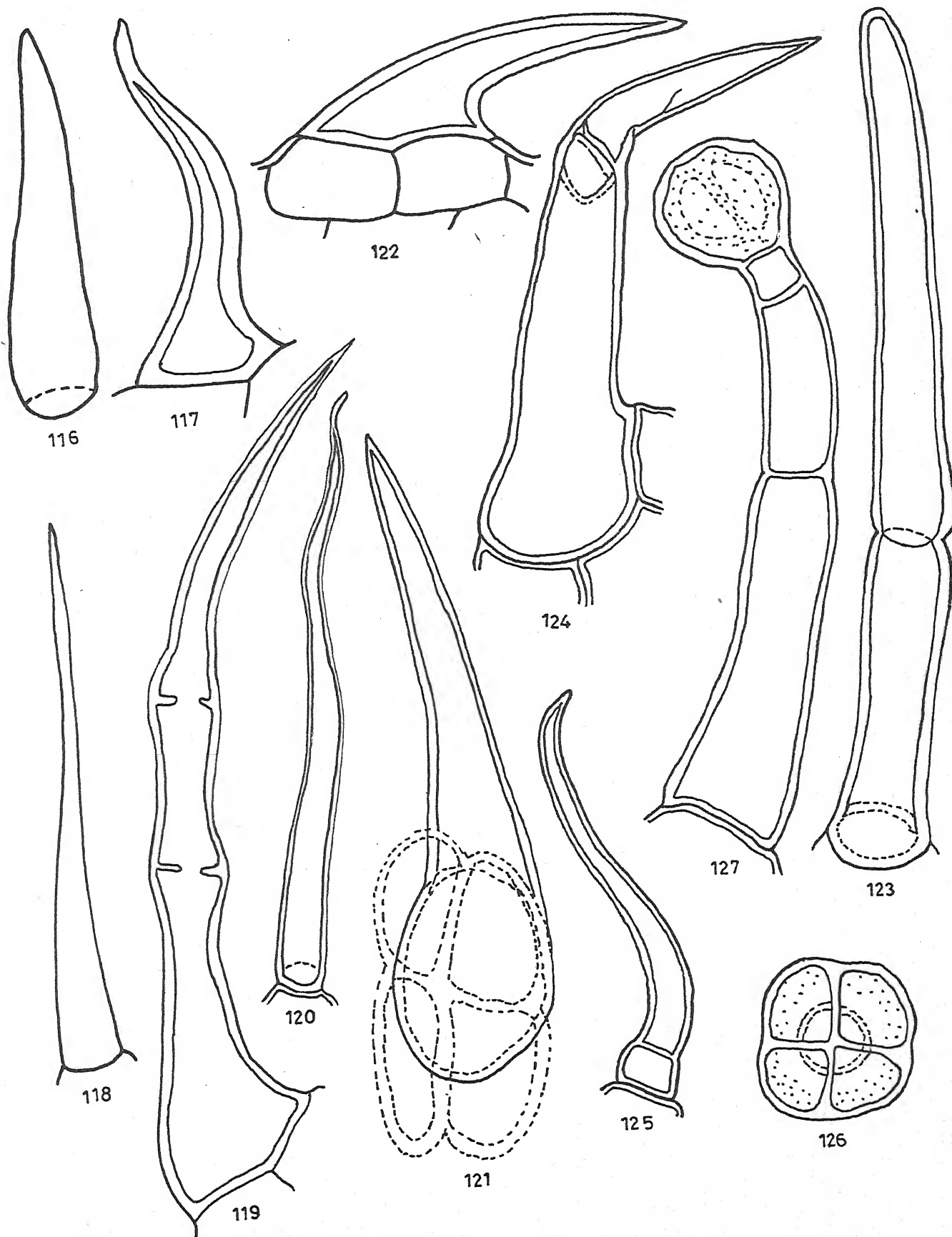


116, 117, 118, 119, 121, 122, 123, 124, 127

120, 125

126

ALL 50 μ



116, 117, 118, 119, 121, 122, 123, 124, 127

120, 125

126

ALL 50 μ

8. Uniseriate glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk 3-celled, long, cylindrical, terminal cell short, collared; head globular, 1-celled, vesiculate; lateral and cross wall thin and smooth; content granulated of head and collared cell, translucent of remaining stalk cells (Fig. 127).

Distrib. : Corolla.

Centranthera neralensis

This species shows seven types of trichomes (Plate 41; Figs. 128-134).

1. Unicellular flagellate

Foot : Simple. Body : 1-celled, entire, long, flagellate, tapering to pointed tip; wall thin and torulose; lumen narrow; content granulated & translucent (Fig. 128).

Distrib. : Corolla - lower surface - tubular part.

2. Unicellular conical

Foot : Sunken, compound. Body : Entire, stiff, erect, conical, tip pointed; wall thick and smooth; lumen wide; narrowing towards distal end; content translucent (Fig. 129).

Distrib. : Leaf - lower surface & margin.

3. Unicellular dentate

Foot : Compound. Body : 1-celled, dentate, erect, tapering to short pointed tip; wall thick and smooth; lumen wide;

content translucent (Fig. 130).

Distrib. : Margins of Leaf, Bract, and Calyx.

4. Bicellular hooked

Foot : Compound. Body : 2-celled, hooked; lower cell erect, rectangular, upper cell deflexed from joint, long, narrow and conical, tip pointed; lateral wall thick and verrucose; cross walls, thick; lumen varied; content dense or translucent (Fig. 131).

Distrib. : Leaf, Inflorescence axis, Bract, Pedicel, and Calyx - upper surface & margin.

5. Bicellular septate flagellate

Foot : Compound. Body : Differentiated, flagellate, upper cell very long, narrower than that of short, erect, lower one; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 132).

Distrib. : Pedicel, Calyx - upper surface and margin.

6. Uniseriate filiform

Foot : Compound. Body : 3-4 celled, entire, filiform, joints pulvinate; terminal cell longest and narrower; lateral and cross walls thin and smooth; lumen narrow; content light yellow (Fig. 133).

Distrib. : Leaf - margin, Inflorescence axis, Bract, and Pedicel.

EXPLANATION OF THE FIGURES OF PLATE - 41

Trichomes from various plant parts

Figs. 128-134 : Centranthera nepalensis

Fig. 128 : Corolla lower surface

Fig. 129 : Leaf lower "

Fig. 130 : Leaf margin

Fig. 131 : Inflorescence axis

Fig. 132 : Calyx margin

Fig. 133 : Bract margin

Fig. 134 : Inflorescence axis

Figs. 135-140 : Sopubia delphinifolia

Fig. 135 : Stem

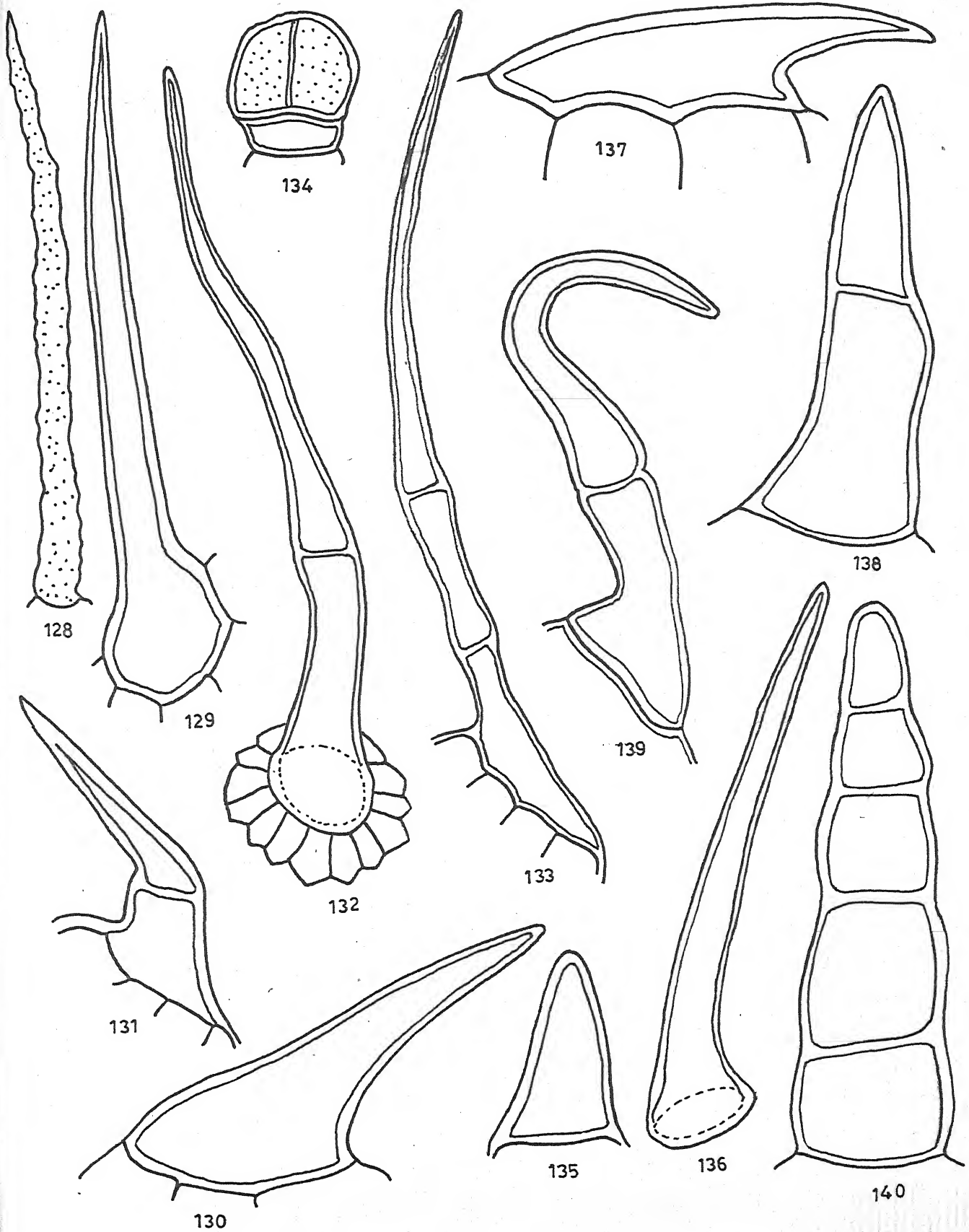
Fig. 136 : Calyx upper surface

Fig. 137 : Leaf margin

Fig. 138 : Leaf

Fig. 139 : Bracteole upper surface

Fig. 140 : Anther filament



128,129,131,132,140

130,133,135,136,137,138,139

134

ALL 50μ

7. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled, broader than long; head globular, 2-4 celled; cells arranged in one tier; outer wall thin and smooth; cross wall thin; content translucent (Fig. 134).

Distrib. : Inflorescence axis, Bract, Pedicel, and Calyx - upper surface.

Scrubia delphinifolia

This species shows eight types of trichomes (Plates 41 & 42; Figs. 135-142).

1. Unicellular papillose

Foot : Simple. Body : Entire, short, erect, papillose, tip round; wall thin and smooth; content translucent (Fig. 135).

Distrib. : Stem, Pedicel, Bracteole, and Style.

2. Unicellular acuminate

Foot : Simple. Body : Entire, erect, acuminate, tip pointed; wall thick and smooth; lumen narrow or wide; content translucent (Fig. 136).

Distrib. : Calyx - upper and lower surface.

3. Unicellular hooked

Foot : Compound. Body : Entire, horizontal, hooked, tip pointed; lateral part prolonged into hook; cell wall thick

and smooth; lumen wide; content translucent (Fig. 137).

Distrib. : Leaf margin, Bracteole, and Calyx margin.

4. Bicellular conical

Foot : Simple. Body : 2-celled, entire, conical, cells of unequal size, upper cell conical, tip pointed; lateral wall thick and smooth; cross wall thin; lumen wide; content light granulated, collapsing (Fig. 138).

Distrib. : Stem, Leaf, Pedicel, Bracteole, Corolla - upper surface, and Style.

5. Bicellular asperate flagellate

Foot : Simple. Body : Entire, lower cell with broader base, upper cell longer, curved and flagellate, tip round; lateral wall thin, smooth and constricted at joints; lumen wide; content translucent, collapsing (Fig. 139).

Distrib. : Bracteole, Calyx, and Corolla.

6. Uniseriate conical

Foot : Simple. Body : Entire, 3-6 celled, straight or bent on one side, cells almost cubical, tip round, lateral wall thick, convex, smooth and constricted at joints; cross walls thin or thick; lumen wide; content translucent, opaque, or dark granulated (Fig. 140).

Distrib. : Stem, Corolla - upper surface, and Anther filaments.

7. Unicellular glandular capitate

Root : Simple. Body : Differentiated; stalk short, 1-celled; head inflated, fan-like, multicellular and irregular, cells of varied shapes, directly seated on the stalk; outer wall convex; content dense granulated (Fig. 141).

Distrib. : Bracteole.

8. Uniseriate glandular capitate vesicular

Root : Simple. Body : Differentiated; stalk 3-celled, long, wide, cylindrical, curved; cells longer than broad, terminal cell short and narrow; head multicellular, round; cells directly arranged on the terminal cell of stalk; vesiculate, enclosing the head irregularly; lateral and cross walls thin and smooth; lumen wide; content of head granulated dense, collapsing and translucent of stalk cells (Fig. 142).

Distrib. : Corolla and Anther filaments.

Sopubia trifida

This species shows seven types of trichomes (Plate 42; Figs. 143-150).

1. Unicellular flagellate

Root : Simple or compound. Body : Entire, long, tubular, narrow (Fig. 143) or distal part extended from broad base (Fig. 144), into long narrow, hyaline, flagellated pointed tip, wall thin or thick and smooth; lumen narrow; content

translucent (Figs. 143, 144).

Distrib. : Leaf - upper surface.

2. Unicellular acerate

Foot : Simple. Body : Entire, straight, stiff acerate, tip pointed; wall thick and smooth; lumen narrow; content translucent (Fig. 145).

Distrib. : Calyx.

3. Unicellular dentate

Foot : Compound. Body : Erect, dentate, gradually narrowing to pointed tip; wall thick and smooth; content translucent (Fig. 146).

Distrib. : Leaf - upper surface and margin.

4. Bicellular curved

Foot : Simple. Body : 2-celled, entire, curved, lower cell erect, upper cell long, curved, gradually narrowing to pointed tip; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 148).

Distrib. : Stem, Leaf - base and margin.

5. Bicellular hooked

Foot : Simple. Body : 2-celled, deflexed, hooked, terminal cell longer and narrower than the broader basal cell, tip

EXPLANATION OF THE FIGURES OF PLATE - 42

Trichomes from various plant parts

Figs. 141-142 : Sorubia delphinifolia

Fig. 141 : Bracteole

Fig. 142 : Corolla upper surface

Figs. 143-150 : Sorubia trifida

Fig. 143 : Calyx upper surface

Fig. 144 : ^aLeaf upper "

Fig. 145 : Calyx upper "

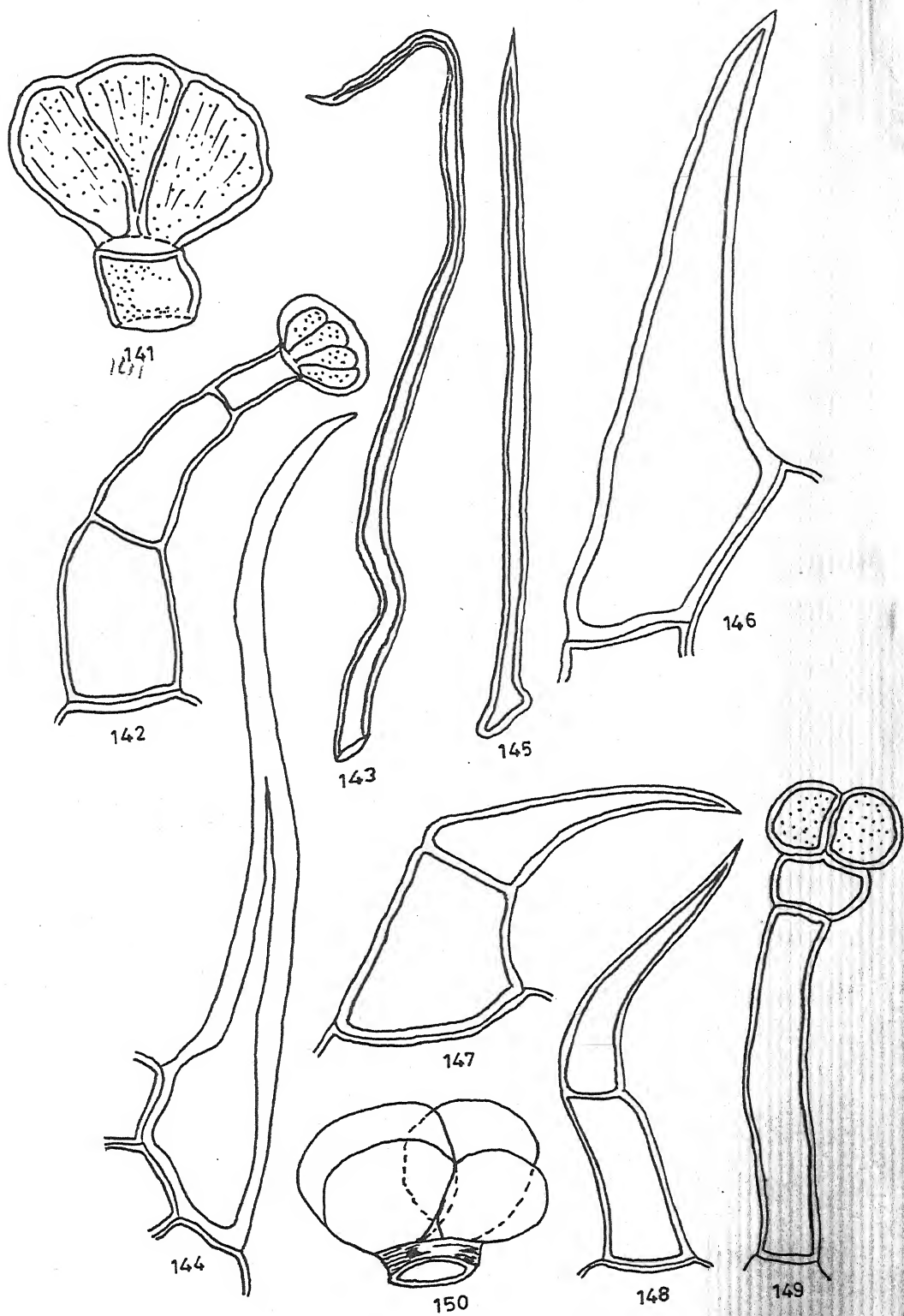
Fig. 146 : Leaf upper "

Fig. 147 : Leaf margin

Fig. 148 : Leaf base

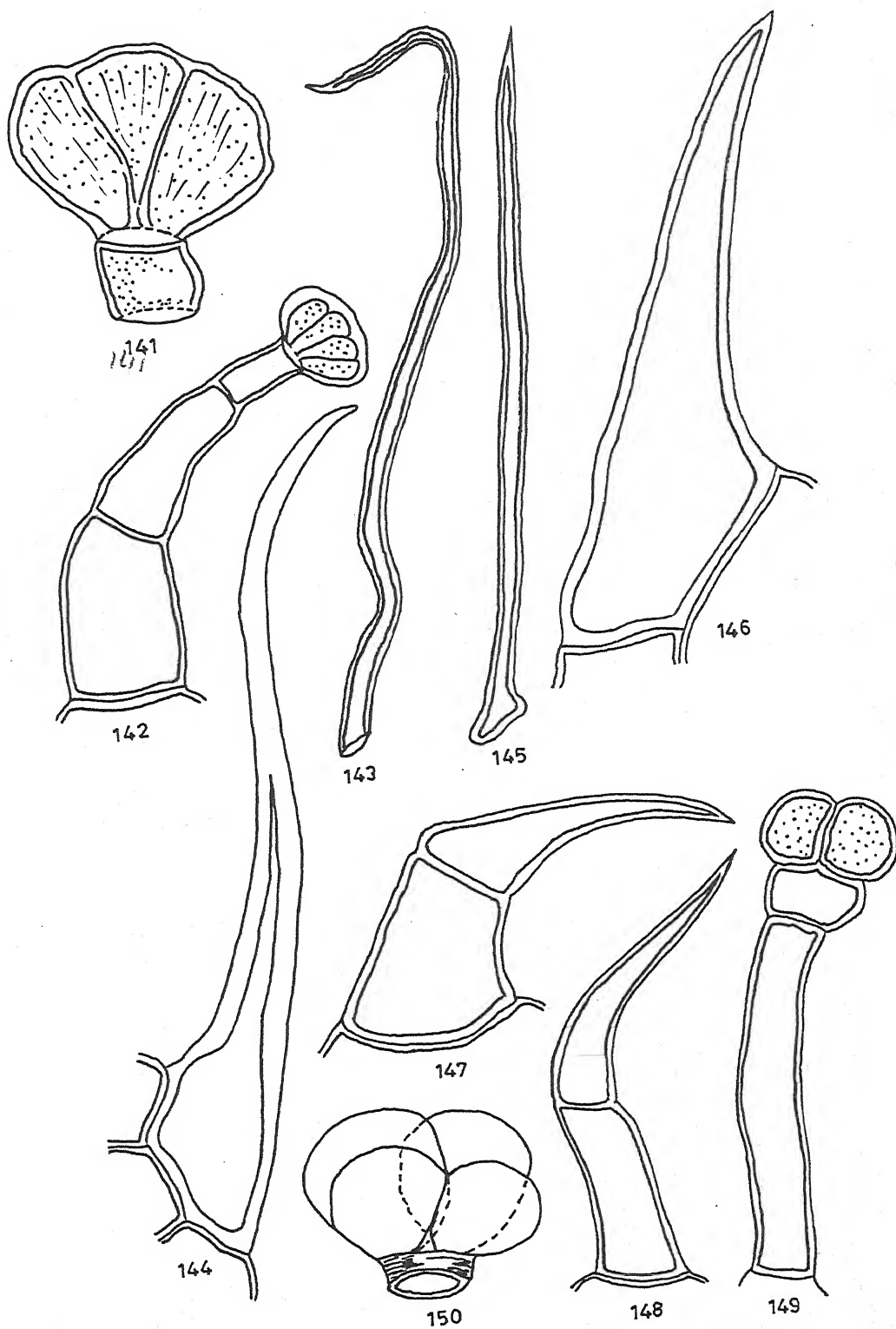
Fig. 149 : Leaf upper surface

Fig. 150 : Bracteole margin.



141, 143, 145
142
144, 146, 147, 148, 149, 150

ALL 50μ



141, 143, 145
 142
 144, 146, 147, 148, 149, 150

ALL 50μ

pointed and bent downward; lateral wall thick, smooth and constricted at joints; content translucent (Fig. 147).

Distrib. : Stem, Leaf - upper surface & margin, and Bracteole - margin.

6. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, lower cell much longer than the upper short and wider cell; head 2-4 celled, each cell globular, arranged in one tier; outer wall thin, uneven and smooth; lateral wall thin and smooth; content dark of upper stalk cell and light granulated of head cells (Fig. 149).

Distrib. : Leaf - upper surface.

7. Brevicollate glandular capitate

Foot : Not visible. Body : Differentiated, sub-sessile; stalk very short; head large, multi-capitate, cap. 1-celled, globular or oblong, large, hyaline, directly arranged in rosette form on the stalk; walls thin and smooth; content translucent (Fig. 150).

Distrib. : Bracteole.

Euphrasia officinalis

This species shows four types of trichomes (Plate 43; Figs. 151-154).

1. Bicellular cylindrical

Foot : Simple. Body : Entire, hyaline, cylindrical, lower

cell short, broader than long, upper cell long, tip round; lateral wall thin and smooth; cross wall thick; lumen wide; content translucent (Fig. 151).

Distrib. : Corolla - upper surface.

2. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 1-celled; head 4-celled, round or apiculate; cells arranged in one tier; outer wall thin and smooth; content of head granulate, dense, and translucent that of stalk (Fig. 152).

Distrib. : Stem, Petiole, Leaf, Pedicel, and Calyx.

3. Bicellular glandular capitate vesicular

Foot : Simple. Body : Differentiated; stalk long, 2-celled, lower cell much longer than the upper short cubical, collar-like cell; head distinct, 4-celled, globular, cells large, horn-like structures projecting beyond the vesicle; outer wall thin, smooth and vesiculate; lateral wall thin and smooth; lumen wide; content translucent (Fig. 153).

Distrib. : Stem, Petiole, Leaf, Pedicel, and Calyx.

4. Brevicollate glandular capitate

Foot : Simple. Body : Differentiated; stalk extremely short, 1-celled, cubical; head large with 2-globular hyaline overlapping cells; outer wall thin and smooth; content granulated & translucent (Fig. 154).

Distrib. : Pedicel, and Calyx.

Euphrasia laxa

This species shows seven types of trichomes
(Plate 43; Figs. 155-161).

1. Unicellular acuminate

Foot : Simple. Body : Entire, slightly curved, tip pointed;
wall thin and smooth; lumen wide; content dense (Fig. 155).
Distrib. : Corolla - lower surface, tubular part.

2. Unicellular conical

Foot : Simple. Body : Entire, tapering to a pointed tip;
wall thin and smooth; lumen wide; content dark (Fig. 156).
Distrib. : Style - upper part, and ovary.

3. Unicellular dentate

Foot : Simple. Body : Entire, erect, dentate, wider at
base, gradually tapering to a pointed tip; wall thick and
smooth; lumen wide; content translucent (Fig. 157).
Distrib. : Leaf, and Calyx margin.

4. Bicellular filiform

Foot : Simple. Body : Entire, sub-erect, filiform, upper
cell longer than the lower one; tip pointed; lateral wall
thin and rugose; cross wall thin; lumen wide; content trans-
lucent (Fig. 158).
Distrib. : Stem.

5. Uniseriate curved

Foot : Simple. Body : Entire, 3-4 celled, curved, tip pointed; lateral wall thin and rugose; cross walls thin; lumen wide; content translucent (Fig. 159).

Distrib. : Stem.

6. Uniseriate aseptate flagellate

Foot : Simple. Body : 3-celled, differentiated; lower two cells short, erect, terminal cell very long, narrow, and flagellate, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content dark of terminal cell, and hyaline of lower cells (Fig. 160).

Distrib. : Corolla - lower, basal tubular part.

7. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-celled, long, cells broader than long; head distinct, 1-celled, spherical; outer and lateral walls thin and smooth; content dark granulated of head, and translucent that of stalk cells (Fig. 161).

Distrib. : Upper surface & margin of Leaf & Calyx, and Corolla lower surface.

EXPLANATION OF THE FIGURES OF PLATE - 43

Trichomes from various plant parts

Figs. 151-154 : Euphrasia officinalis

Fig. 151 : Corolla upper surface

Fig. 152 : Stem

Fig. 153 : Leaf

Fig. 154 : Calyx

Figs. 155-161 : Euphrasia laxa

Fig. 155 : Corolla lower surface

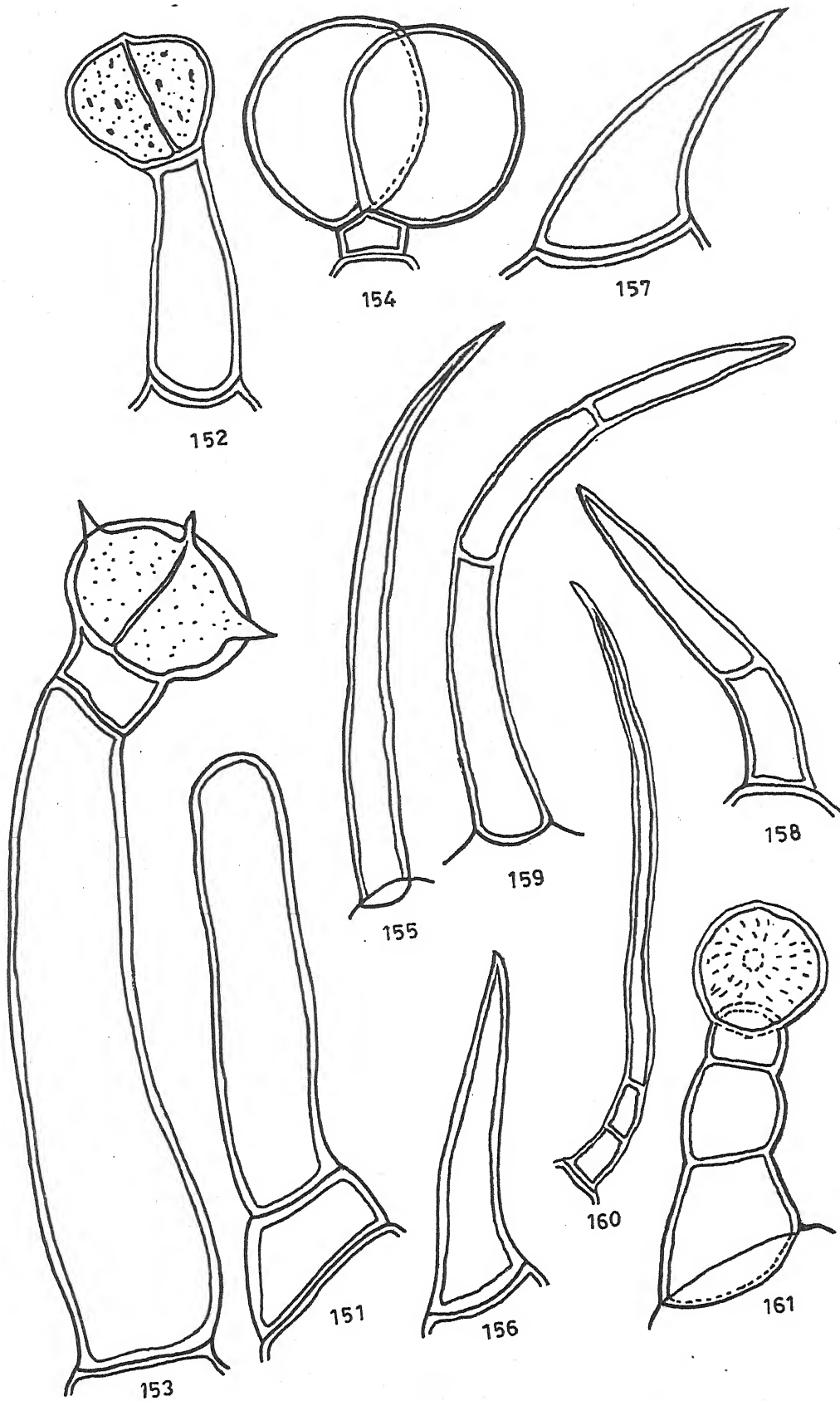
Fig. 156 : Style

Fig. 157 : Leaf margin

Figs. 158, 159 : Stem

Fig. 160 : Corolla lower surface

Fig. 161 : Leaf margin



151, 153
 152, 154, 155, 156, 157, 161
 158, 159, 160

ALL 50 μ

Euphrasia jaeschkei

This species shows five types of trichomes
(Plate 44; Figs. 162-166).

1. Unicellular conical

Foot : Simple. Body : Entire, conical, tip pointed; wall thick and smooth; lumen narrow; content dark (Fig. 162).

Distrib. : Style, and Ovary.

2. Bicellular aseptate flagellate

Foot : Simple. Body : Differentiated; lower cell elongated, erect, upper cell much longer, narrow and flagellate, tip pointed; lateral wall thin and smooth; lumen wide or narrow; content dense or translucent (Fig. 163).

Distrib. : Stem, and Corolla - lower surface.

3. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 3-5 celled; cells longer than broad, flagellate, tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 164).

Distrib. : Stem.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, short, cells of equal size, broader; head 1-celled, globular,

apiculate; walls thin and smooth; content of head dark granulated and translucent of basal stalk cell (Fig. 165).

Distrib. : Leaf - upper surface & margin, Calyx, and Corolla - lower surface.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-5 celled, cells longer than broad, terminal cell short, collar-like; head 1-celled, ovular and apiculate; walls thin and smooth; content of head dark, nucleated & granulated, and translucent of stalk cells (Fig. 166).

Distrib. : Stem.

Pedicularis pectinata var. bipinnatifida

This species shows five types of trichomes (Plate 44; Figs. 167-172).

1. Unicellular papillose

Foot : Simple. Body : 1-celled, short, dome-shaped; outer wall thin, hyaline and smooth; lumen wide, content translucent (Fig. 167).

Distrib. : Leaf.

2. Uniseriate filiform

Foot : Simple. Body : Entire, 3-5 celled, filiform, cells longer than broad; tip rounded; lateral and cross walls

thin and smooth; lumen narrow; content translucent (Fig. 168).

Distrib. : Anther filaments.

3. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 4-10 celled, long, narrow hyaline, flagellate, cells much longer than broad, terminal cell short; tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 169).

Distrib. : Bract, margin, Calyx - upper surface, and Anther filaments.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short and broad; head very large, globular, 4-celled; outer wall thin and smooth; content granulated, translucent (Fig. 170).

Distrib. : Corolla.

5. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 2-celled, cells broader than long; head globular, 1-celled; (Fig. 176); or 4-celled (Fig. 177); outer wall thin and smooth; content dark granulated of head, and translucent of stalk cells (Figs. 176 & 177).

Distrib. : Bract, Calyx - upper surface, and Corolla - lower surface.

pedicularis pectinata var. typica

This species shows five types of trichomes
(Plate 44; Figs. 173-177).

1. Uniseriate filiform

Foot : Simple. Body : Entire, 4-6 celled, filiform, cells longer than broad, tip slightly round; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 173).

Distrib. : Stem, Petiole, Leaf - lower surface along mid rib, and Calyx.

2. Uniseriate cylindrical

Foot : Simple. Body : Entire, 3-6 celled, cylindrical, lower cells longer than upper, short, cubical cells, tip round; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 174).

Distrib. : Stem, Petiole, and Corolla - upper surface.

3. Uniseriate curved

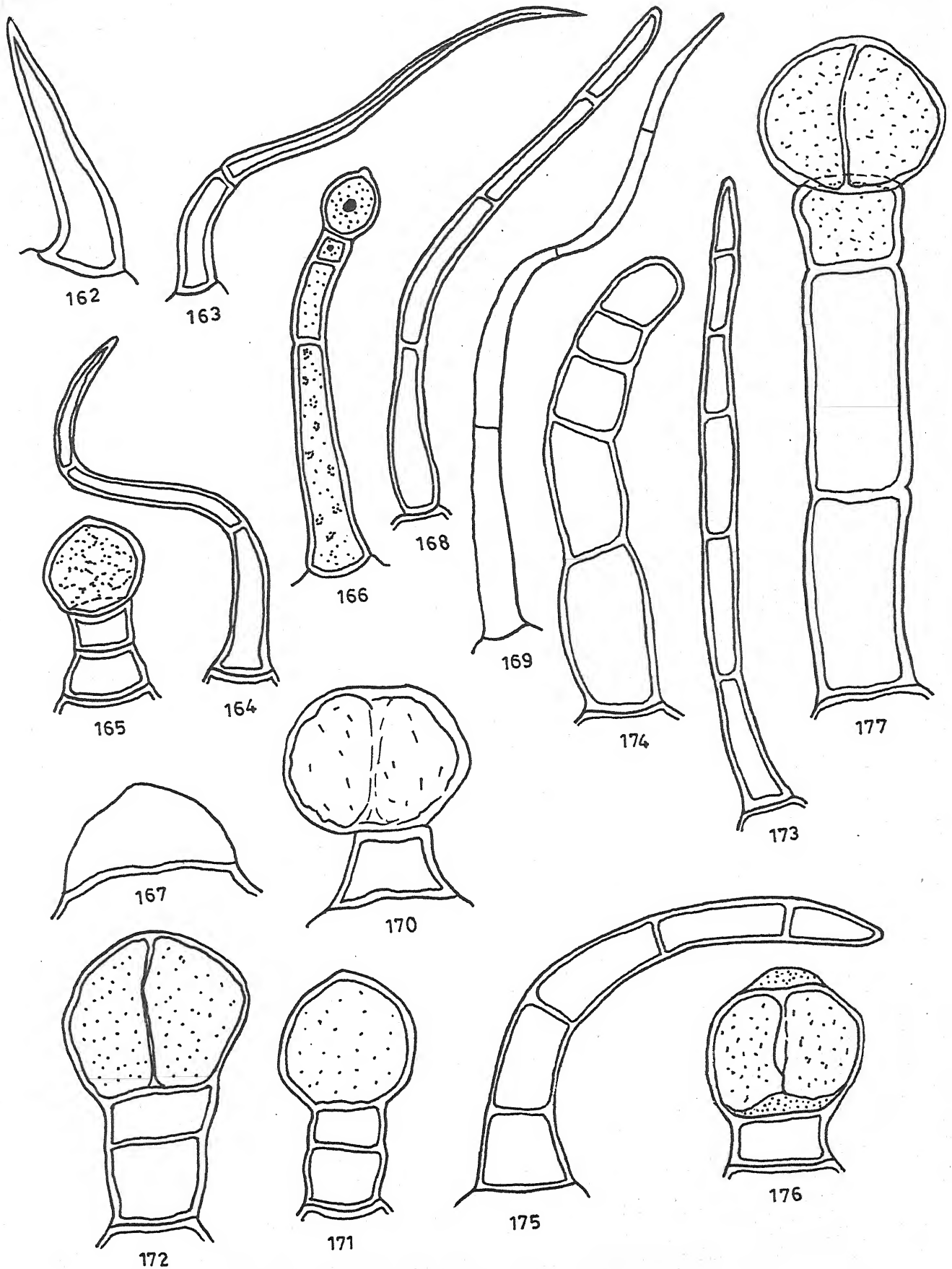
Foot : Simple. Body : Entire, 4-6 celled, curved, tip slightly round; cells longer than broad; lateral and cross walls thin and smooth; lumen wide; content translucent. (Fig. 175).

Distrib. : Stem, Petiole, Leaf - lower surface along mid rib, upper surface of Calyx and Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 44

Trichomes from various plant parts

- Figs. 162-166 : Euphrasia jaeschkei
- Fig. 162 : Style
- Fig. 163 : Corolla lower surface
- Fig. 164 : Stem
- Fig. 165 : Corolla lower surface
- Fig. 166 : Stem
- Figs. 167-172 : Pedicularis pectinata ssp. bipinnatifida
- Fig. 167 : Leaf lower surface
- Fig. 168 : Anther filament
- Fig. 169 : Calyx upper surface
- Fig. 170 : Corolla lower "
- Fig. 171 : Calyx upper "
- Fig. 172 : Corolla upper "
- Figs. 173-177 : Pedicularis pectinata var. typica
- Fig. 173 : Stem
- Fig. 174 : Petiole
- Fig. 175 : Stem
- Fig. 176 : Corolla upper surface
- Fig. 177 : Calyx upper



162, 167, 170, 171, 172, 176, 177

163, 164, 166, 174, 175

165, 168, 173

169

ALL 50μ

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 1-celled; head large, dome-shaped, 4-celled; outer wall thin and smooth; content dark granulated of head, and translucent that of stalk cell (Fig. 176).

Distrib. : Calyx, Corolla and Anther.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk long, 3-6 celled, hyaline, cylindrical, cells longer than broad, except terminal one; head globular, 2-4 celled, outer and lateral walls thin and smooth; content light & granulated of head, and translucent of lower stalk cells (Fig. 177).

Distrib. : Calyx, and Corolla - lower surface.

Pedicularis brevifolia

This species shows three types of trichomes (Plate 45; Figs. 178-180).

1. Uniseriate filiform

Foot : Simple. Body : Entire, 5-12 celled, very long, filiform, cells becoming gradually longer and narrower from base to apex; tip round; lateral and cross walls thin and smooth; lumen wide; content granulated, translucent, collapsing (Fig. 178).

Distrib. : Calyx - upper surface & margin, and Anther filaments.

2. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 6-8 celled, long, flagellate, tip round; lateral and cross walls thin and smooth; lumen narrow; content opaque, and persisting (Fig. 179).

Distrib. : Stem.

3. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 2-celled, cells of unequal size, lumen wide; head 2-4 celled, dome-shaped; cells arranged in one tier; outer wall thin and smooth; content of head dark, granulated, and translucent of stalk cells (Fig. 180).

Distrib. : Corolla.

Pedicularis flammosa

This species shows five types of trichomes (Plate 45; Figs. 181-185).

1. Uniseriate filiform

Foot : Simple. Body : Entire, 7-12 celled, filiform, cells longer than broad, tip round; lateral wall thin, smooth and constricted at joints; cross walls thin; lumen narrow; content translucent (Fig. 181).

Distrib. : Stem, Leaf, Corolla - lower surface and margin.

2. Uniseriate conical

Foot : Simple. Body : Entire, 5-8 celled, erect, conical, cells of various sizes, gradually becoming shorter and narrower, terminal cell shortest; tip pointed; lateral wall thick or thin, smooth, convex and constricted at joints; cross walls thick; lumen wide; content opaque (Fig. 182).

Distrib. : Stem, and Leaf.

3. Uniseriate cylindrical

Foot : Simple. Body : Entire, erect, broad, cylindrical, longer than broad, tip round; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 183).

Distrib. : Corolla - lower surface and margin.

4. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 3-5 celled, hyaline, flagellate, cells longer than broad, tip pointed, lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 184).

Distrib. : Stem, Calyx, and Corolla.

5. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk, 1-celled, broader than long; head, 2-4 celled, dome-shaped; cells directly seated on stalk, in one tier; outer wall thin and smooth; content dark (Fig. 185).

Distrib. : Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 45

Trichomes from various plant parts

Figs. 178-180 : Pedicularis brevifolia

Fig. 178 : Calyx margin

Fig. 179 : Stem

Fig. 180 : Corolla upper surface

Figs. 181-185 : Pedicularis flexuosa

Fig. 181 : Leaf upper surface

Fig. 182 : Leaf lower "

Fig. 183 : Corolla lower "

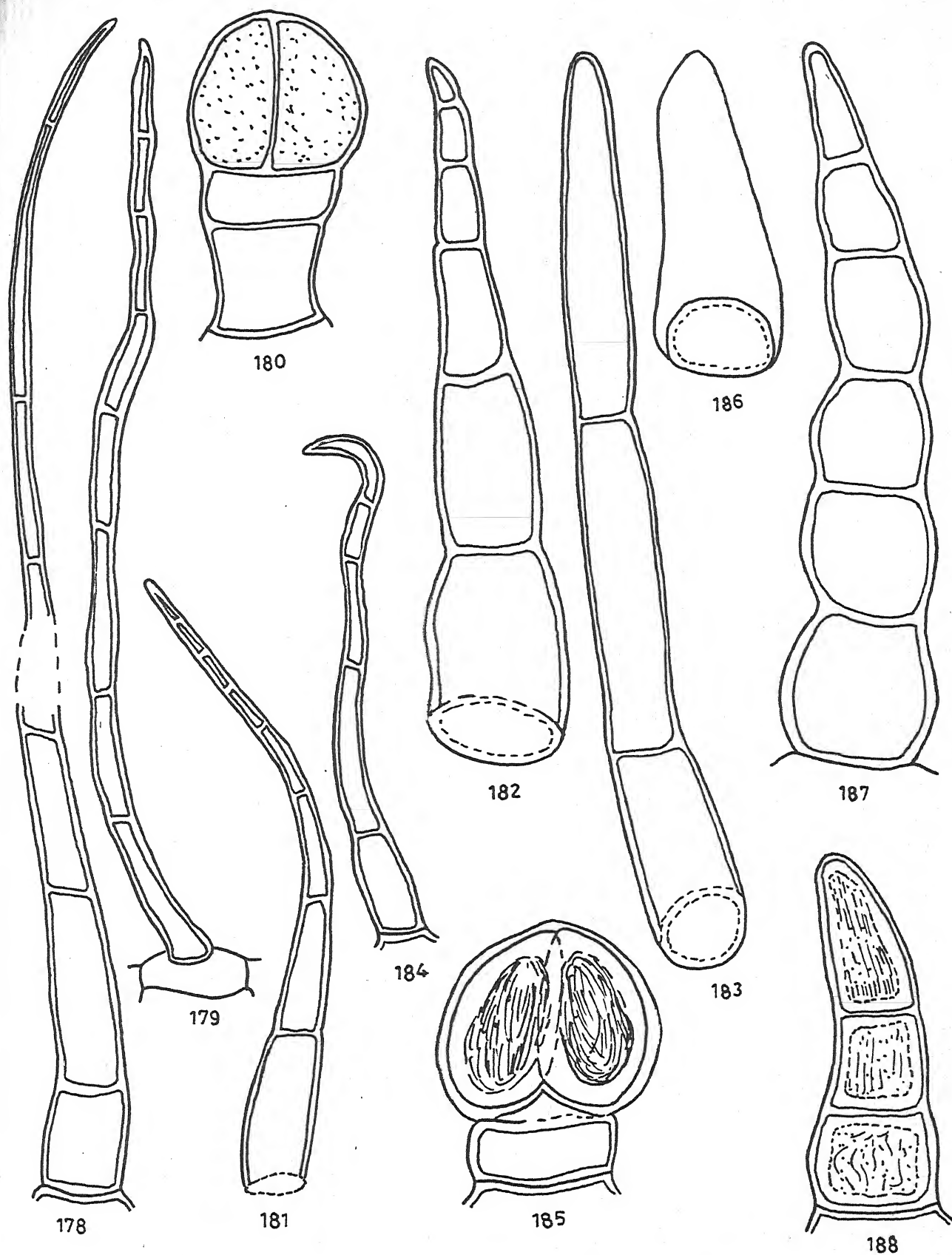
Figs. 184, 185 : Corolla upper "

Figs. 186-188 : Pedicularis verticillata

Fig. 186 : Corolla lower surface

Fig. 187 : Stem

Fig. 188 : Corolla lower surface



178,179,182
180,183,186,187,188

181
184
185

ALL 50μ

Pedicularis verticillata

This species shows eight types of trichomes
(Plates 45 & 46; Figs. 186-193).

1. Unicellular papillose

Foot : Simple. Body : Entire, short, hyaline, papillose, tip round; wall thin and smooth; lumen wide; content translucent (Fig. 186).

Distrib. : Corolla - lower surface.

2. Uniseriate conical

Foot : Simple. Body : Entire, 3-9 celled, conical; cells of equal size, barrel-shaped, except terminal long and narrow one; tip round; lateral wall thin, smooth, convex, and constricted at joints; cross walls thin; lumen wide; content translucent (Fig. 187).

Distrib. : Stem, Calyx - lower surface and margin.

3. Uniseriate cylindrical

Foot : Simple. Body : Entire, 3-celled, cylindrical, cells iso-diametric or elongated, tip round; lateral wall thick and smooth; cross walls thin; lumen wide; content dark (Fig. 188).

Distrib. : Corolla - lower surface.

4. Uniseriate curved

Foot : Simple. Body : Entire, 3-6 celled, curved, cells of varied shapes and sizes; tip pointed; lateral wall thin, smooth and constricted at joints; cross walls thin; lumen wide, content translucent (Fig. 189).

Distrib. : Stem.

5. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 5-13 celled, very long, flagellate, lower few cells wider than those of distal end, tip pointed; lateral wall thin, smooth and convex; cross walls thin; lumen wide; content translucent (Fig. 190).

Distrib. : Stem, Bract, Calyx - lower surface and margin.

6. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 1-celled, short and broad; head large, 2-4 celled, globular; outer wall thin and smooth; content of head light granulated, and dark of stalk cell (Fig. 191).

Distrib. : Stem, Bract margin, Calyx, and Corolla.

7. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, 2-celled, terminal cell dark collar-like; head 1-celled, inflated; outer wall thin and irregular; lateral wall thin and convex;

cross walls thin; content of head light granulated and translucent of basal stalk cell (Fig. 192).

Distrib. : Calyx - upper surface & margin, and Corolla - lower surface.

8. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk, 4-celled, long, cells of varied length and shape, terminal cell short, dark, collar-like, lower two cells moniliform; head 1-celled, hemispherical, outer wall thin and smooth; lateral wall thin, smooth, convex or concave and constricted at joints; content of head light granulated, and translucent of stalk cells except terminal one (Fig. 193).

Distrib. : Calyx - upper surface and margin.

Pedicularis bifida

This species shows five types of trichomes (Plate 46, Figs. 194-198).

1. Uniseriate filiform

Foot : Simple. Body : Entire, 3-10 celled, long, filiform, cells longer than broad, tip round; lateral wall thin and smooth; cross walls thin, lumen wide; content translucent (Fig. 194).

Distrib. : Stem, Leaf - lower surface along mid rib & margin, and Calyx - margin & tip.

2. Uniseriate conical

Foot : Simple. Body : Entire, short, 3-6 celled, conical, cells more or less cubical; lateral wall thin, smooth, convex and constricted at joints; cross walls thin; lumen wide; content translucent (Fig. 195).

Distrib. : Calyx tips.

3. Uniseriate curved

Foot : Simple. Body : Entire 3-5 celled, curved, cells longer than broad; tip round; lateral wall thin, smooth, convex and constricted at joints; cross walls thin, lumen wide; content translucent (Fig. 196).

Distrib. : Calyx - upper surface and margin.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk, 1-celled, short, wider than length; head 1-celled, dome-shaped, outer wall thin and smooth; lateral wall convex, constricted at joints; cross walls thin; content dark of head and light that of stalk cell (Fig. 197).

Distrib. : Leaf, and Calyx - lower surface.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk, long 3-5 celled; cells rectangular; head large 2-4 celled, with apical hyaline notch; lateral and cross walls thin and

EXPLANATION OF THE FIGURES OF PLATE - 46

Trichomes from various plant parts

Figs. 189-193 : Pedicularis verticillata

Fig. 189 : Stem

Fig. 190 : Calyx margin

Fig. 191 : Calyx upper surface

Fig. 192 : Corolla lower "

Fig. 193 : Calyx margin

Figs. 194-198 : Pedicularis bifida

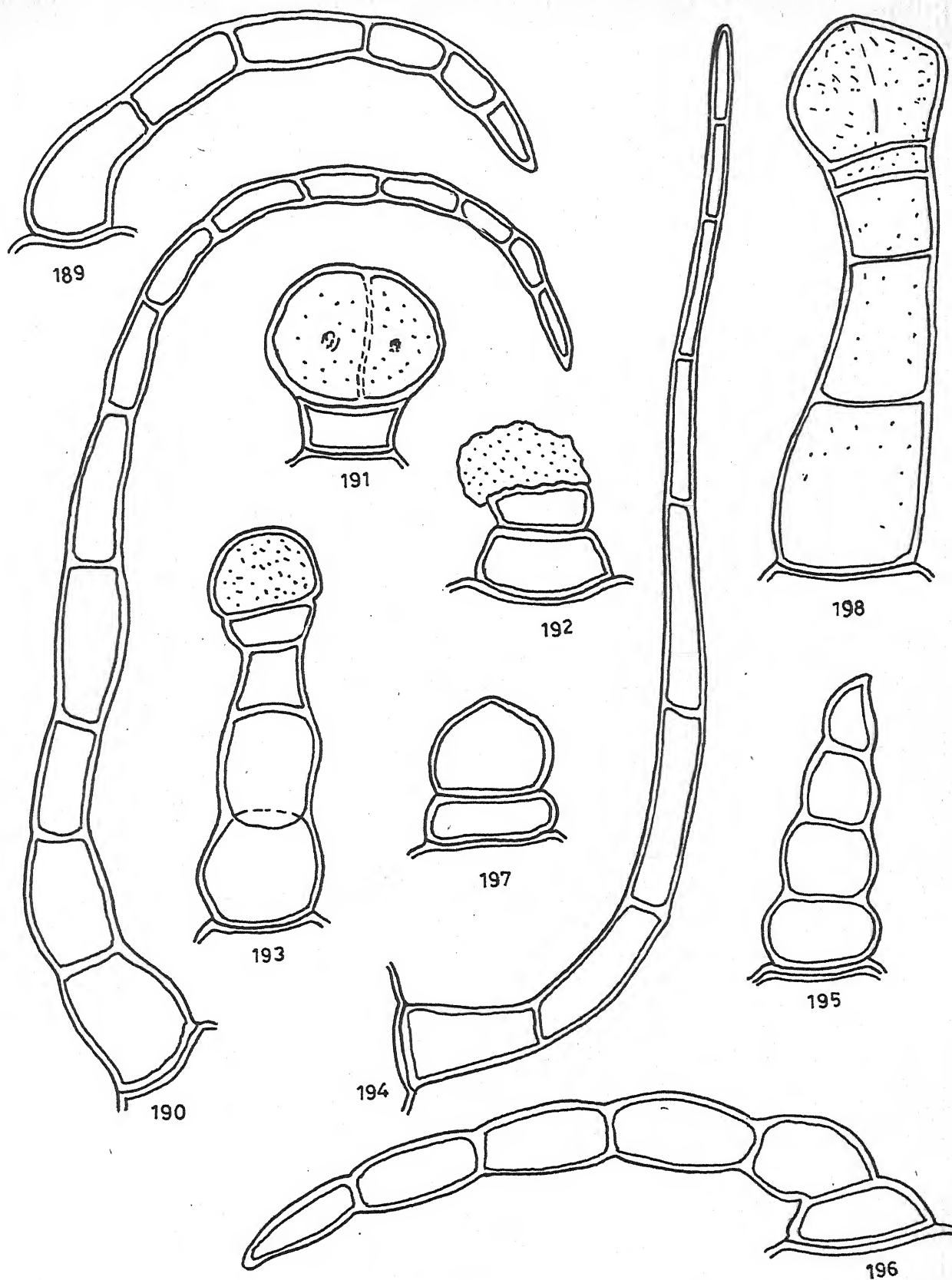
Fig. 194 : Leaf lower surface

Fig. 195 : Calyx tips

Fig. 196 : Calyx margin

Fig. 197 : Leaf lower surface

Fig. 198 : Leaf lower "



189

190

191

192, 193, 195, 196, 197, 198

194

ALL 50 μ

smooth; content granulated, dense of head, and translucent of stalk (Fig. 198).

Distrib. : Leaf - lower surface.

Pedicularis asplenifolia

This species shows four types of trichomes (Plate 47; Figs. 199-202).

1. Uniseriate filiform

Foot : Simple. Body : Entire, 4-13 celled; long filiform, cells longer than broad, tip pointed; lateral and cross walls thin and smooth; lumen wide; content translucent (Fig. 199).

Distrib. : Stem, Pedicel, and Calyx.

2. Uniseriate curved

Foot : Simple. Body : Entire, 3-celled, curved, body deflexed from the basal erect cell, terminal cell much longer than the others; tip pointed; lateral wall thin, smooth and constricted at joints; cross walls thin, lumen wide; content translucent (Fig. 200).

Distrib. : Stem, Pedicel, and Calyx - lower surface and margin.

3. Uniseriate septate flagellate

Foot : Simple. Body : Entire, 3-5 celled flagellate, cells

longer than broad, terminal cell longest; tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 201).

Distrib. : Corolla - lower surface & margin, and Anther filaments.

4. Unicellular glandular capitate

Foot : Simple. Body : Globular, differentiated; stalk, 1-celled broader, cup-like; head 1-celled, hemispherical, with slight depression at tip; outer wall thin and smooth; content of stalk dark, light and granulated of head (Fig. 202).

Distrib. : Corolla - lower surface and margin.

Pedicularis pyramidata

This species shows five types of trichomes (Plate 47; Figs. 203-207).

1. Unicellular papillose

Foot : Simple. Body : Entire, short, hyaline, tip round; wall thin and smooth; lumen wide; content translucent (Fig. 203).

Distrib. : Leaf - lower surface.

2. Uniseriate filiform

Foot : Simple. Body : 6-10 celled, entire, filiform.

cells small, rectangular, tip round; lateral and cross walls thin and smooth; lumen narrow; content yellowish (Fig. 204).
 Distrib. : Corolla - lower surface.

3. Uniseriate cylindrical

Root : Simple. Body : Entire, 4-8 celled, cylindrical, light striations on entire body, cells longer than broad, tip round; lateral and cross walls thin and smooth; lumen wide; content yellowish (Fig. 205).

Distrib. : Stem, Leaf, Corolla - lower surface and Anther filaments.

4. Uniseriate septate flagellate

Root : Simple. Body : 4-12 celled, long, flagellate, cells longer than broad, tip pointed, or round; lateral and cross walls thin and smooth; lumen narrow; content yellowish (Fig. 206).

Distrib. : Calyx - upper surface and Anther filaments.

5. Bicellular glandular capitate

Root : Simple. Body : Differentiated; stalk 2-celled, short, upper cell smaller, contents darker than the lower, larger hyaline one; head round, large, 4-celled; outer wall thin and smooth, content yellowish & granulated (Fig. 207).

Distrib. : Leaf, Calyx, and Corolla.

EXPLANATION OF THE FIGURES OF PLATE - 47

Trichomes from various plant parts

Figs. 199-202 : Pedicularis asplenifolia

Fig. 199 : Calyx margin

Fig. 200 : Corolla lower surface

Fig. 201 : Corolla lower "

Fig. 202 : Corolla lower "

Figs. 203-207 : Pedicularis pyramidata

Fig. 203 : Leaf lower surface

Fig. 204 : Corolla lower "

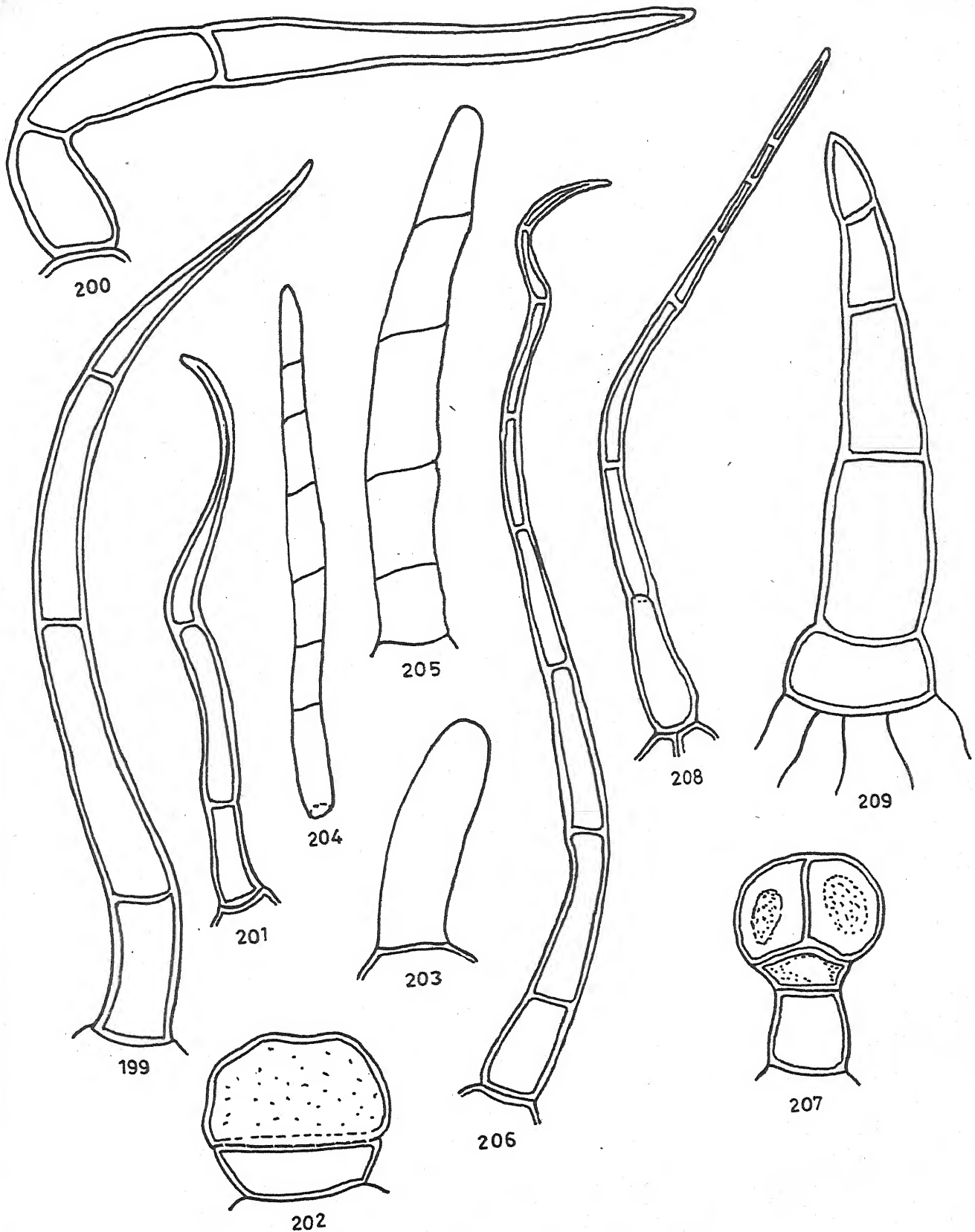
Fig. 205 : Corolla lower "

Figs. 206, 207 : Calyx upper "

Figs. 208-209 : Pedicularis plantilingii

Fig. 208 : Bract upper surface

Fig. 209 : Bract tips



199, 200	_____	} ALL 50μ
201, 203, 205, 209	_____	
202	_____	
204, 207	_____	
206, 208	_____	

Pedicularis plantilingii

This species shows four types of trichomes
(Plate 47 & 48; Figs. 208-211).

1. Uniseriate filiform

Foot : Compound. Body : Entire, 4-9 celled, filiform, cells longer than broad, gradually becoming shorter and narrower towards distal end; tip round; lateral and cross walls thin and smooth; lumen narrow (Fig. 208).

Distrib. : Stem, Bract and Calyx - lower surface.

2. Uniseriate conical

Foot : Compound. Body : Entire, 4-5 celled, stout, conical, tip pointed; cells longer than broad except basal cell; lateral wall thick, smooth and slightly constricted at joints; cross walls thin; lumen wide; content yellowish (Fig. 209).

Distrib. : Upper surface and tips of leaf & Bract, and Calyx.

3. Uniseriate septate flagellate

Foot : Compound. Body : 4-12 celled, long, flagellate, cells longer than broad, gradually narrowing towards distal end; tip pointed; lateral and cross walls thin and smooth; lumen narrow; content translucent (Fig. 210).

Distrib. : Calyx - upper surface, and Corolla.

4. Bicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk 2-celled, short, cells wider than long, head globular, large, 4-celled, outer wall thick and smooth; content dense, dark (Fig. 211).
Distrib. : Corolla - upper surface.

Pedicularis oederi

This species shows five types of trichomes
(Plate 48; Figs. 212-216).

1. Bicellular hooked

Foot : Simple. Body : 2-celled, hooked, basal cell arrect; upper cell long, narrow and conical, tip round; lateral wall thick, smooth and constricted, at joint; cross wall thick; lumen wide; content light, granulated (Fig. 212).
Distrib. : Leaf - lower surface, and bract.

2. Uniseriate filiform

Foot : Simple. Body : Entire, 3-6 celled, filiform, cells long and narrow; tip round; lateral and cross walls thin and smooth; lumen narrow; content light granulated (Fig. 213).
Distrib. : Anther filaments.

3. Uniseriate septate flagellate

Foot : Simple. Body : 3-6 celled, very long, flagellate, cells much longer than broad; tip round; lateral wall thin,

smooth and undulated; cross walls thin; lumen wide; gradually becoming narrower towards distal end; content light, & granulated, collapsing, some cells nucleated (Fig. 214).

Distrib. : Stem, Bract, and Calyx - margin.

4. Unicellular glandular capitate

Foot : Simple. Body : Differentiated; stalk short, discoid, 1-celled, broader than long; head 1-celled, hemispherical, having hyaline infoldings outer wall thin, smooth, but uneven in the head; cross wall thin; content dark of stalk and light granulated in the head (Fig. 215).

Distrib. : Leaf, Bract, Calyx, and Corolla - lower surface.

5. Uniseriate glandular capitate

Foot : Simple. Body : Differentiated; stalk 3-celled, long, basal cell long and wide, terminal cell short, collar-like; head 1-celled, small, round; outer wall thin and uneven; lateral and cross walls thin and smooth; content light of stalk, and dark, granulated of head (Fig. 216).

Distrib. : Calyx - lower surface.

EXPLANATION OF THE FIGURES OF PLATE - 48

Trichomes from various plant parts

Figs. 210-211 : Pedicularis plantilingii

Fig. 210 : Calyx upper surface

Fig. 211 : Corolla upper

Figs. 212-216 : Pedicularis oderi

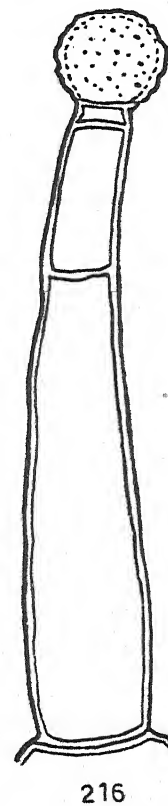
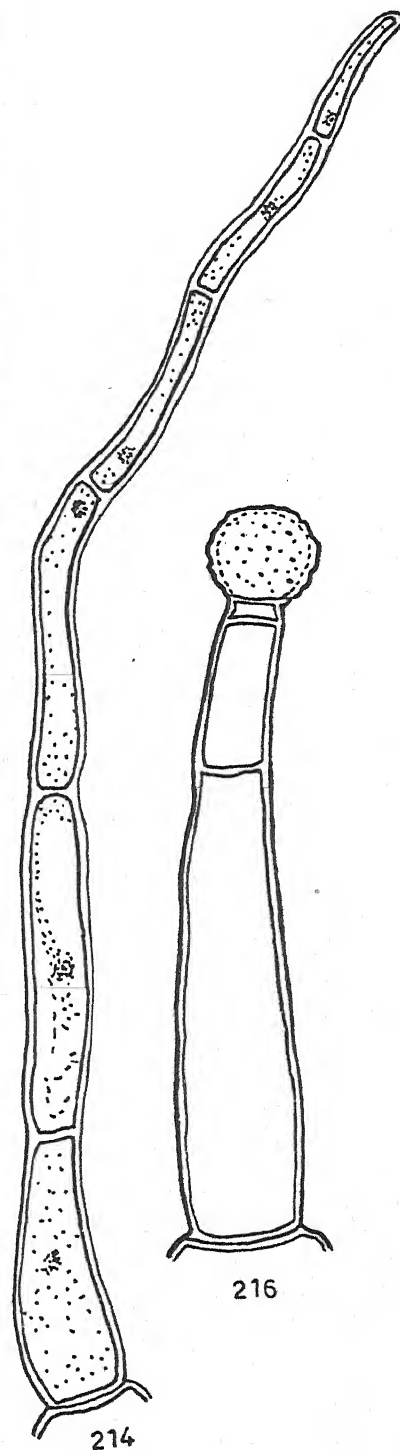
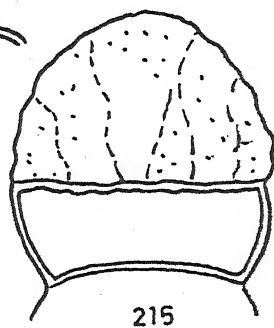
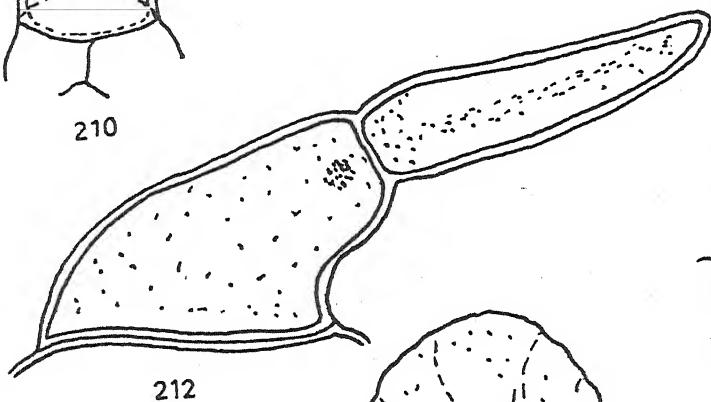
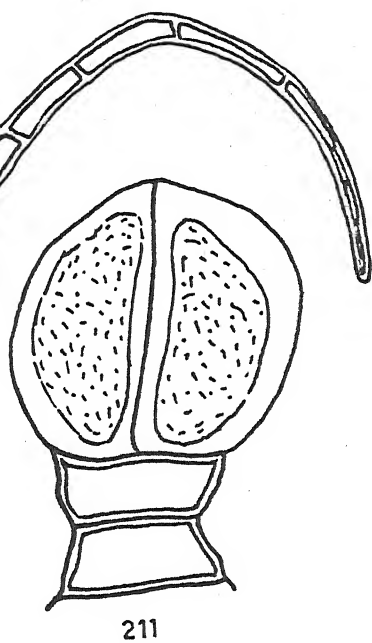
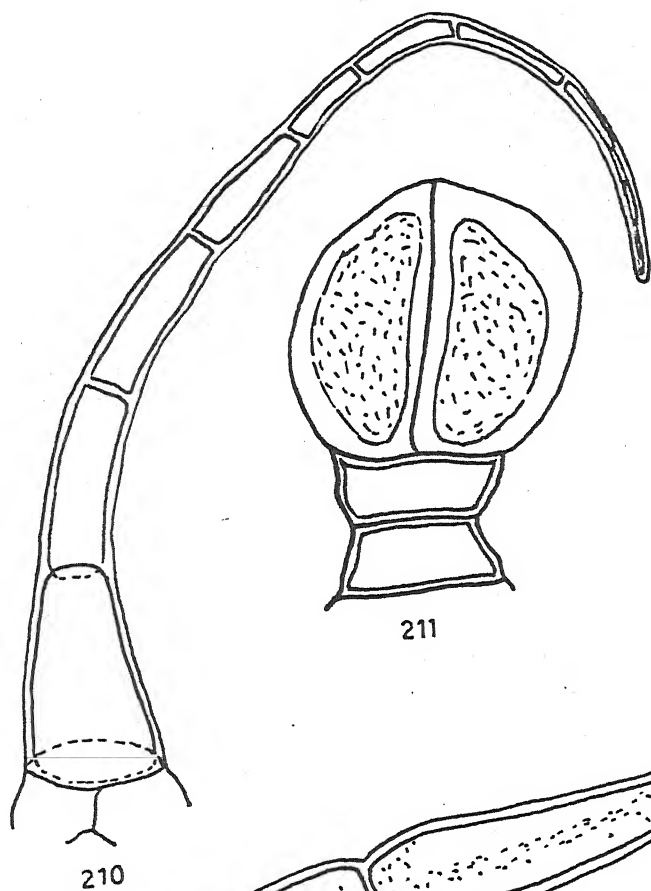
Fig. 212 : Bract

Fig. 213 : Anther filament

Fig. 214 : Calyx margin

Fig. 215 : Corolla lower surface

Fig. 216 : Calyx lower "



210	—
211, 215	—
212	—
213	—
214	—
216	—

ALL 50 μ

CHAPTER IV

OBSERVATION AND DISCUSSION

- a) Series - Pseudosolanaceae
- b) Series - Antirrhinideae
- c) Series - Rhinanthideae

CHAPTER - IV

OBSERVATION AND DISCUSSION

(a) SERIES - PSEUDOSOLANACEAE

In the present investigations, 7 species belonging to 3 genera of the series Pseudosolanaceae were selected. The study revealed a total number of 24 trichome types of both nonglandular (19 types) and glandular (5 types) categories. The trichomes were observed on the vegetative as well as floral parts (Table IV, Plate 49). Organographic distribution of these trichomes is given in Table V and their specieswise distribution in Table VI. According to Hooker (1885), the series Pseudosolanaceae is comparatively smaller than the other two, comprising of two tribes i.e., Aptosineae and Verbasceae. The former has only one genus Anticharis, and the latter, two genera Verbascum and Celsia. Species of these taxa were studied for their trichomes.

From the perusal of Table VI, it is clear that some trichomes are common to most of the species while

others are not so common and restricted in their distribution as is evident by their presence only in one or two species of this series. For example, the trichomes which are unicellular clavate, sessile stellate multiradiate, stalked stellate multiradiate and bicellular glandular capitate are more common and were recorded in 4 species, while unicellular conical, unicellular glandular capitate and uniseriate glandular capitate ones were observed in three of the studied species of this series. Other types of trichomes are restricted only to a few species viz., unicellular papillose (Anticharis linnearis and Verbascum thapsus), dendroid (V. thapsus & V. erianthum) and peltate porous glandular (V. erianthum & V. spongaceum) and unicellular flagellate, unicellular cylindrical, bicellular conical & uniseriate conical in Anticharis glandulosa; stalked stellate tetraradiate in V. thapsus, sessile stellate triradiate in V. erianthum, unicellular acuminate in V. adenospermum, unicellular filiform, stalked stellate biradiate, stalked stellate triradiate & brevicollate glandular capitate in V. spongaceum and unicellular dentate, bicellular asperate flagellate and uniseriate filiform in Celsia coromandeliana.

The aforesaid trichome types because of their restricted distribution, help in distinguishing species from others, in which they occur.

Maximum number of trichome types were recorded in 4 species vis., Verbascum soongraceum (9 types) followed by Anticharis linearis, V. thapsus and V. erianthum (7 types each).

When some forms of trichomes are common in two or more species other forms of them help in distinguishing these species. For example, in all the 4 species of Verbascum investigated, stalked stellate multiradiate and sessile stellate multiradiate trichomes are common, but these 4 species can be distinguished on the basis of the presence of other forms, as V. thapsus in having stalked stellate tetraradiate; V. erianthum with sessile stellate triradiate; V. adnaseplum with unicellular acuminate and V. soongraceum by unicellular filiform, stalked stellate biradiate, stalked stellate triradiate and brevicolate glandular capitate forms, which are distinctive for these species and have taxonomic significance.

Similarly, Anticharis glandulosa and A. linearis have common type of trichomes, like unicellular conical, unicellular glandular capitate and uniseriate glandular capitate, but these can be easily separated on the basis of other trichome types. The former shows unicellular flagellate, unicellular cylindrical, bicellular conical and uniseriate conical, whereas the later having unicellular papillose and unicellular dentate (Table VI). Moreover,

the organographic distribution and frequency of the afore-said trichomes common to these two species also reveal clear differences among them (Table V).

It has been observed during collection that species of Verbascum are quite distinguishable by their wooly and villous nature of leaves from Celsia coromandeliana (Syn. Verbascum chinensis), whose leaves are not villous.

The study of trichomes of 4 species of Verbascum and Celsia coromandeliana revealed a remarkable difference. C. coromandeliana can be distinguished from other species of Verbascum by totally lacking the dendroid and various types of stellate forms. This separation of Celsia from other species of Verbascum can also be supported by the bicellular aseptate flagellate and uniseriate filiform hairs which have not been observed in any of the taxa of the series. Therefore, this taxon is rightly separated from Verbascum and is given the generic status Celsia. As found in the species of Verbascum in the present study, Metcalfe and Chalk (1950) had also demonstrated the presence of branched, stellate and dendroid forms of trichomes in the species of Verbascum and genera Leucophyllum & Paulownia of this series.

The trichome studies have also revealed similarities between C. coromandeliana and two species of

Anticharis in showing unicellular glandular capitate and uniseriate glandular capitate trichomes. However, Celsia can be delimited by the presence of unicellular clavate and bicellular glandular capitate trichomes in addition to the bicellular aseptate flagellate and uniseriate filiform types.

So far as the distribution of trichome types is concerned, nonglandular types are represented more in number than the glandular ones, viz., V. erianthum, V. thapsus & V. spongaceum each shows 6 types of nonglandular, while only one type of glandular trichome.

Among the nonglandular types, various forms of unicellular (clavate & conical) trichomes are more common in distribution than the others, while in the glandular category of trichomes, bicellular glandular capitate forms are represented by more species than the other forms.

Organographic distribution of trichomes

(Table V) also reveals some interesting results. All the glandular types of trichome are more commonly distributed on vegetative parts than on the floral organs. These are found on pedicels, calyx and corolla. Out of two essential parts of a flower the stamens do not show any glandular type of trichomes whereas other parts i.e., style, stigma

and ovary show an abundance of uniseriate glandular capitate trichomes. In addition to this, style also shows frequent occurrence of unicellular glandular capitate forms. Since these trichomes were found only in Anticharis glandulosa of this series, their taxonomic importance for its separation from other taxa of the series is evident.

Organographic distribution of glandular trichomes on floral parts also helps in the separation of 4 species of Verbascum from each other. V. erianthum and V. adenocephalum do not possess glandular trichomes, while remaining two species of Verbascum i.e., V. soongoraense & V. thapsus showed the presence of glandular trichomes on floral parts. V. thapsus & V. soongoraense can further be separated from each other, the former in having the particular type of glandular trichomes bicellular glandular capitate only on calyx and the latter showing different types of glandular trichomes on pedicel, calyx and corolla.

Organographic distribution of nonglandular type of trichomes is very interesting. Some are found only on floral portion or on the vegetative parts or on both these organs, such as uniseriate conical, sessile stellate triradiate, stalked stellate biradiate and stalked stellate triradiate types on floral parts, unicellular dentate and

bicellular aseptate flagellate forms on vegetative organs. Remaining types under nonglandular category i.e., unicellular papillose, unicellular clavate, unicellular flagellate, unicellular filiform, unicellular acuminate, unicellular conical and unicellular cylindrical, bicellular conical, uniseriate filiform, sessile stellate multi-radiate, stalked stellate tetroradiate and stalked stellate multiradiate and dendroid forms occur on both the organs. The distribution of unicellular dentate, bicellular aseptate flagellate, sessile stellate triradiate, stalked stellate biradiate & stalked stellate triradiate is significant because of their restricted distribution. These were observed only on a particular part of a single species e.g., unicellular dentate on leaf of Anticharis linearis, bicellular aseptate flagellate on stem of A. glandulosa, sessile stellate triradiate on ovary of Verbascum erianthum, and stalked stellate biradiate & stalked stellate triradiate on the style of V. spongaceum. Because of the restricted distribution of these forms of trichomes, they are of taxonomic significance.

Metcalf and Chalk (1950) have studied trichomes of the Scrophulariaceae, scattered in all the three series of the family. As per their observations, the taxa of this series mostly show nonglandular trichomes, among which

unicellular types are more common out of 19 nonglandular types observed, unicellular hairs were grouped into 8 categories.

Solereder (1908) described peltate glandular hairs in the taxa of this family. In a few species of this series (V. erianthum & V. soongraecum), the peltate glandular discs have porous centre and due to this character, the term peltate porous glandular is used in the present study for such types of trichomes.

Datta and Deb (1975) recorded a few forms of hairs on the floral parts of the Scrophulariaceae, and stated that glandular types of hairs are more common than the nonglandular ones. It is in contrast to the trichome studies of this series, where nonglandular forms are more common. Their study on trichomes on the floral parts of this family is restricted only to a few taxa and they have recorded a limited number of types of hairs. The species of Verbascum virgatum studied by Datta and Deb (loc. cit) showed unicellular conical and uniseriate types while in the present investigations it has been found that the 4 species studied are characterized by the presence of stellate, branched and various glandular types of trichomes as recorded by Metcalfe and Chalk (1950).

TOTAL TRICHOME TYPES IN THE SERIES PSEUDOSOLANACEAE

Explanation of the figures of Plate - 49

Fig. No.	Trichome types	Taken from	
		Plate No.	Fig. No.
1.	Unicellular papillose	1	9
2.	Unicellular calvate	6	41
3.	Unicellular flagellate	1	1
4.	Unicellular filiform	5	33
5.	Unicellular acuminate	4	28
6.	Unicellular conical	1	10
7.	Unicellular cylindrical	1	3
8.	Unicellular dentate	1	11
9.	Bicellular conical	1	5
10.	Bicellular aseptate flagellate	6	42
11.	Uniseriate filiform	6	43
12.	Uniseriate conical	1	6
13.	Sessile stellate triradiate	3	23
14.	Sessile stellate multiradiate	4	29
15.	Stalked stellate biradiate	5	35
16.	Stalked stellate triradiate	5	36
17.	Stalked stellate tetraradiate	2	17
18.	Stalked stellate multiradiate	3	25
19.	Dendroid	4	26
20.	Peltate porous glandular	5	38
21.	Unicellular glandular capitate	1	12
22.	Bicellular glandular capitate	4	31
23.	Uniseriate glandular capitate	6	47
24.	Brevicollate glandular capitate	5	40

TOTAL TRICHOME TYPES IN THE SERIES PSEUDOSOLANAEAE

Explanation of the figures of Plate - 49

Fig. No.	Trichome types	Taken from	
		Plate No.	Fig. No.
1.	Unicellular papillose	1	9
2.	Unicellular calvate	6	41
3.	Unicellular flagellate	1	1
4.	Unicellular filiform	5	33
5.	Unicellular acuminate	4	28
6.	Unicellular conical	1	10
7.	Unicellular cylindrical	1	3
8.	Unicellular dentate	1	11
9.	Bicellular conical	1	5
10.	Bicellular aseptate flagellate	6	42
11.	Uniseriate filiform	6	43
12.	Uniseriate conical	1	6
13.	Sessile stellate triradiate	3	23
14.	Sessile stellate multiradiate	4	29
15.	Stalked stellate biradiate	5	35
16.	Stalked stellate triradiate	5	36
17.	Stalked stellate tetraradiate	2	17
18.	Stalked stellate multiradiate	3	25
19.	Dendroid	4	26
20.	Peltate porous glandular	5	38
21.	Unicellular glandular capitate	1	12
22.	Bicellular glandular capitate	4	31
23.	Uniseriate glandular capitate	6	47
24.	Brevicollate glandular capitate	5	40

PLATE-49

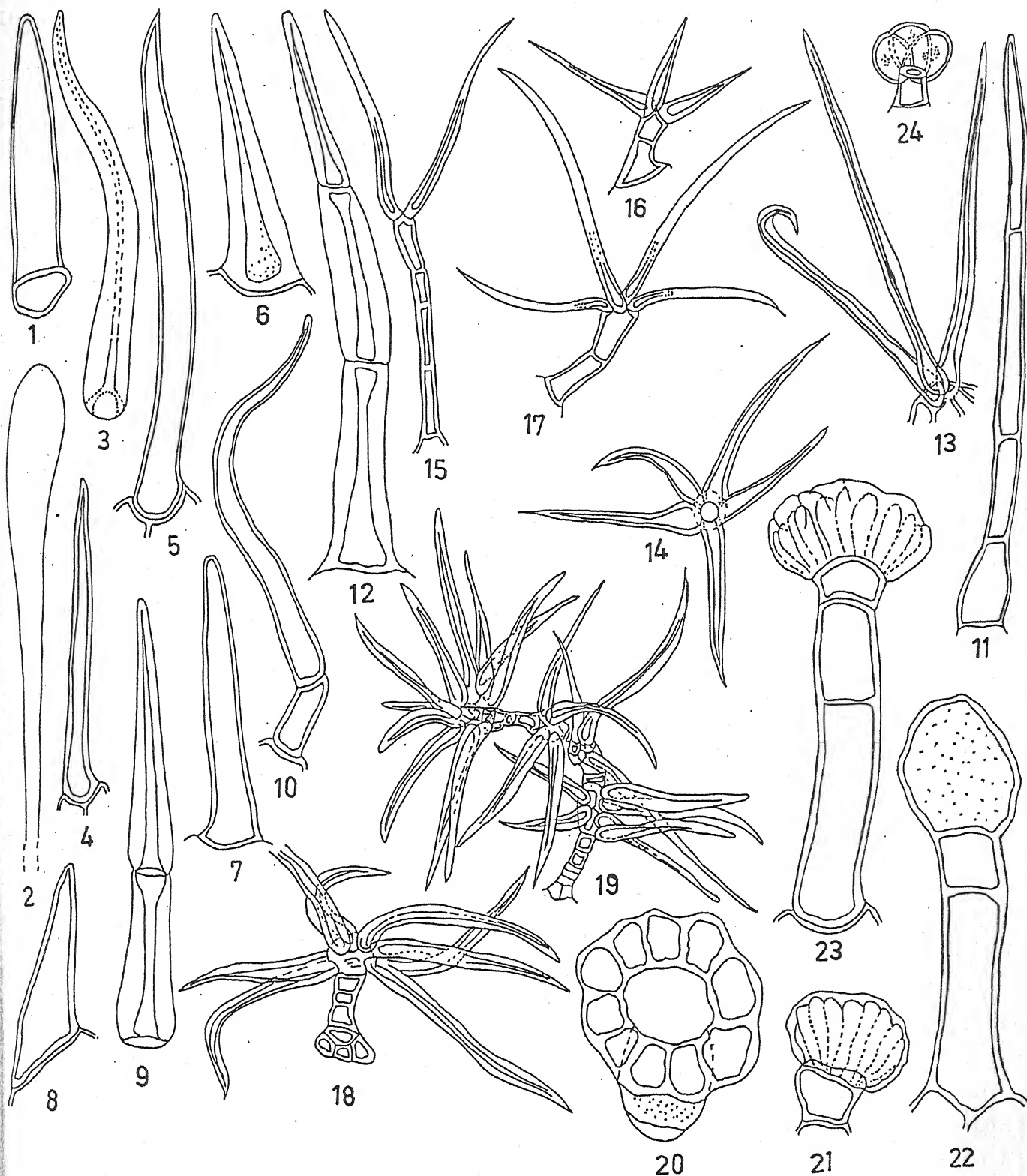


TABLE - IV : TOTAL TRICHOME TYPES OBSERVED IN THE SERIES PSEUDOSOLANAEAE

S.No.	Trichome types	Code
<u>Nonglandular</u>		
1.	Unicellular papillose	A ₁
2.	Unicellular clavate	A ₂
3.	Unicellular flagellate	A ₃
4.	Unicellular filiform	A ₄
5.	Unicellular acuminate	A ₆
6.	Unicellular conical	A ₇
7.	Unicellular cylindrical	A ₉
8.	Unicellular dentate	A ₁₁
9.	Bicellular conical	B ₂
10.	Bicellular aseptate flagellate	B ₇
11.	Uniseriate filiform	C
12.	Uniseriate conical	D
13.	Sessile stellate triradiate	L ₁
14.	Sessile stellate multiradiate	L ₂
15.	Stalked stellate biradiate	M ₁
16.	Stalked stellate triradiate	M ₂
17.	Stalked stellate tetraradiate	M ₃
18.	Stalked stellate multiradiate	M ₄
19.	Dendroid	N
<u>Glandular</u>		
20.	Peltate porous glandular	O
21.	Unicellular glandular capitate	R
22.	Bicellular glandular capitate	T
23.	Uniseriate glandular capitate	W
24.	Brevicollate glandular capitate	Y

TABLE - V A : ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES AND THEIR FREQUENCY IN THE TAXA OF SERIES - PSEUDOSOLANAEAE

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>Anticharis glandulosa</u>	III III I III A ₇ A ₉ B ₂ W	-	II II III A ₃ A ₉ W	I III A ₉ W	-	-
<u>A. linearis</u>	II III III A ₁ R W	-	II A ₁	III III III II A ₁ A ₇ A ₁₁ W	-	-
<u>Verbascum thapsus</u>	III III III M ₃ M ₄ N	-	III III III III L ₂ M ₃ M ₄ N	III III M ₃ M ₄	-	-
<u>V. orianthum</u>	III III III M ₄ N Q	-	III M ₄	III M	-	-
<u>V. adenosclum</u>	III III A ₆ L ₂	-	III III III I A ₆ L ₂ M ₄ T	III III III I A ₆ L ₂ M ₄ T	-	-
<u>V. soongracum</u>	III III II III II A ₄ L ₂ Q T Y	-	II III III II A ₄ L ₂ M ₄ Y	III III III II A ₄ L ₂ M ₄ T	-	-
<u>Celsia coromandeliana</u>	I III II III B ₇ C T W	-	III III II III C R T W	I W	-	III III R W

I = scarce; II = frequent; III = abundant

TABLE - V B : ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES IN THE TAXA OF SERIES - PSEUDOSOLANEA

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Style-stigma	Ovary
<u>Anticharis glandulosa</u>	III III III II A ₇ A ₉ B ₂ D	II II III A ₇ B ₂ W	II II III A ₃ A ₇ W	III W	I I I A ₉ B ₂ D	III II W R	III W
<u>A. linearis</u>	II A ₇	-	III III A ₇ W	-	-	-	-
<u>Verbascum thapsus</u>	-	III III L ₂ N	III III III III L ₂ M ₃ M ₄ N II T	II III III L ₂ M ₃ N	III III A ₁ A ₂	III M ₄	III III L ₂ M ₄
<u>V. orianthum</u>	-	III M ₄	III III M ₄ N	III III L ₂ M ₄	I A ₂	-	III III A ₇ L ₁
<u>V. adnoseplum</u>	-	III III III A ₆ L ₂ M ₄	III III III A ₆ L ₂ M ₄	III III III A ₆ L ₂ M ₄	-	III A ₆	III III III A ₆ L ₂ M ₄
<u>V. soongraceum</u>	III II II M ₄ T Y	-	II III III II A ₄ L ₂ M ₄ O II II T Y	II III III II A ₄ L ₂ M ₄ T II Y	III A ₂	II I III III A ₄ M ₁ M ₂ M ₄	II A ₄
<u>Celsia coromandeliana</u>	III III C W	III II C W	III II C W	III II A ₂ W	-	-	-

TABLE - VI : SPECIESWISE DISTRIBUTION OF TRICHOMES IN THE SERIES - PSEUDOSOLANAEAE

Trichome types	Code	TAXA NOS.							No. of species
		1	2	3	4	5	6	7	
Unicellular papillose	A ₁		+	+					2
Unicellular clavate	A ₂			+	+		+	4	4
Unicellular flagellate	A ₃	+							1
Unicellular filiform	A ₄						+		1
Unicellular acuminate	A ₆					+			1
Unicellular conical	A ₇	+	+		+				3
Unicellular cylindrical	A ₉	+							1
Unicellular dentate	A ₁₁		+						1
Bicellular conical	B ₂	+							1
Bicellular aseptate flagellate	B ₇							+	1
Uniseriate filiform	C							+	1
Uniseriate conical	D	+							1
Sessile stellate triradiate	L ₁				+				1
Sessile stellate multiradiate	L ₂			+	+	+	+		4
Stalked stellate biradiate	M ₁						+		1
Stalked stellate triradiate	M ₂						+		1
Stalked stellate tetraradiate	M ₃			+					1
Stalked stellate multiradiate	M ₄			+	+	+	+		4
Dendroid	N			+	+				2
Peltate porous glandular	O				+		+		2
Unicellular glandular capitate	R	+	+					+	3
Bicellular glandular capitate	T			+		+	+	+	4
Uniseriate glandular capitate	W	+	+					+	3
Brevicollate glandular capitate	Y						+		1
Number of types of trichome: per species		7	5	7	7	4	9	6	

TABLE - VII : DISTRIBUTION OF TRICHOMES ON DIFFERENT PARTS IN THE TAXA OF SERIES - PSEUDOSOLANAEAE

Organs	Trichome types																				Glandular					Total No. of types of tri- chomes
	Non glandular																									
	A ₁	A ₂	A ₃	A ₄	A ₆	A ₇	A ₉	A ₁₁	B ₂	B ₇	C	D	L ₁	L ₂	M ₁	M ₂	M ₃	M ₄	N	O	R	T	W	Y		
Stem	+			+	+	+	+		+	+	+			+			+	+	+		+	+	+	+	+	17
Leaf	+		+	+	+	+	+	+			+			+			+	+	+			+	+	+	+	16
Inflores- cence axis																						+		+		2
Pedicel						+	+		+		+	+						+				+	+	+	+	10
Bract/ Bracteole					+	+			+		+			+				+	+					+		8
Calyx			+	+	+	+					+			+			+	+	+		+		+	+	+	13
Corolla		+		+	+									+			+	+	+			+	+	+		10
Stamen	+	+					+		+			+														5
Carpel				+	+	+							+	+	+	+		+				+		+		10

+ = presence

(b) SERIES ANTIRRHINIDEAE

Antirrhinideae is the second and largest of the three series of Scrophulariaceae. Hooker (1885) placed four tribes, Antirrhinae, Cheloneae, Manuleae and Gratiolaee in this series. The last of the four has been further divided by him into five sub-tribes viz., Mimuleae, Stenodiceae, Harpestideae, Vandeliaceae and Limoselleae. The present investigations include taxa from all these tribes. A total number of 36 trichome types, both nonglandular (25 types) and glandular (11 types) were observed (Table VIII) on the vegetative as well as floral organs of 52 species belonging to 24 genera of the series.

From the category of nonglandular form of hairs, the most common type recorded are unicellular dentate, unicellular papillose types (each in 16 species), unicellular clavate (15 species), unicellular flagellate (14 species), unicellular conical (12 species), uniseriate conical (11 species), bicellular cylindrical and uniseriate septate flagellate (each in 7 species) (Table X). Some forms of hairs have restricted distribution and are confined to

3 to 5 species. Remaining forms are rare and were recorded only in one or two species i.e., bicellular aseptate flagellate and bicellular furcate in Lindenbergia indica and Russelia coccinia, unicellular acerat^e in L. grandiflora & L. muraria, bicellular acuminate in L. grandiflora & Vandellia mollis, uniseriate hooked in Limnophila indica & Torenia cordifolia, uniseriate acuminate in Lindenbergia grandiflora and Vandellia mollis, and uniseriate aseptate flagellate in Lindenbergia muraria & Torenia violacea. The trichomes which are restricted to only a single species are bicellular aseptate flagellate types found in Lindenbergia indica and bicellular furcate types found in Russelia coccinia (Table X).

Amongst the glandular forms, uniseriate glandular capitate ones are most common, recorded in 26 species followed by unicellular glandular capitate types observed in 24 species, bicellular glandular capitate ones in 21 species, peltate porous glandular in 12 species, uniseriate glandular & brevicoliate glandular capitate each in 4 species, bicellular glandular capitate vesicular and uniseriate glandular capitate vesicular each in 3 species and unicellular glandular capitate vesicular could be seen only in one species i.e., Limnophila gratioloidea (Table X).

Among the nonglandular forms, unicellular types are more abundant (10 types) followed by uniseriate (8 types) and bicellular hairs (7 types). The glandular types are represented by uniseriate glandular and peltate glandular (3 types of each), unicellular glandular and bicellular glandular (2 types of each) and brevicoliate glandular capitate forms (Table VIII).

The trichomic significance has been established by the contributions of many workers (Ramayya, 1972; Sahu, 1982b, 1984, 1985; Mishra, 1984). In the present investigations also they have been found to play an important role in taxonomic delimitation of the taxa of Scrophulariaceae. Two species of *Linaria* i.e., *L. ramosissima* & *L. vulgaris* are similar in having common forms of hairs i.e., unicellular papillose and uniseriate glandular capitate but the former shows bicellular filiform, bicellular conical and uniseriate cylindrical hairs, while the latter is characterized in having unicellular clavate, unicellular conical, unicellular dentate and bicellular glandular capitate types. Further, unicellular papillose and uniseriate glandular capitate hairs in *L. ramosissima* were recorded on both vegetative and floral parts (including ovary) while *L. vulgaris* showed their presence only on floral parts especially on calyx and corolla.

Studied species of Antirrhinum are similar only in having uniseriate glandular capitate vesicular hairs which are seen on both vegetative and floral parts of both the species, but these species i.e., A. granthum and A. majus fall apart from each other in other forms of trichome compliments. The former is having unicellular clavate and the latter unicellular papillose and uniseriate cylindrical forms.

All the 5 species of Scrophularia are closely related in having common glandular types of trichomes. Scrophularia calycina, S. urticaefolia, S. polyantha, S. decomposita var. typica & S. decomposita ssp. latifolia exhibit the occurrence of unicellular glandular capitate hairs. Though the first three species exhibit common forms of hairs i.e., bicellular capitate and uniseriate glandular capitate hairs. S. urticaefolia in addition to sharing common types of trichomes with other species can be separated from others in having unicellular papillose, bicellular cylindrical and uniseriate glandular ones. While S. calycina and S. polyantha are identical in having common four types of hairs, but these can be distinguished in their organographic distribution. Unicellular glandular capitate and brevicollate glandular capitate are recorded on both vegetative and floral parts of S. calycina, whereas

in case of S. polyantha, these are observed only on stem. The corolla of S. calycina possesses unicellular glandular capitate, uniseriate glandular, bicellular glandular capitate and brevicolate glandular capitate forms of hairs, whereas in S. polyantha only bicellular glandular capitate types occur. On the pedicel of the former species no trichome were recorded, whereas in the latter only bicellular glandular capitate were recorded. In addition to these distinctions, these two species of Scrophulariaceae showed a marked difference in the trichomes of stamens, thus showing their taxonomic value. Analysis of the trichome complement on different organs of the S. decomposita var. typica & S. decomposita ssp. latifolia suggested that both these stand apart from each other. These two taxa share unicellular glandular capitate type of hairs as the common type. Moreover, the abundant presence of uniseriate glandular capitate hairs only on the anther filament of S. decomposita var. typica makes it distinct from others. S. decomposita ssp. latifolia shows bicellular glandular capitate, bicellular glandular capitate vesicular & brevicolate glandular capitate types of trichomes. The presence of bicellular glandular capitate vesicular hairs is a distinctive feature for this species as it has not been observed not only in other variety of S. decomposita, but also in another species of Scrophularia studied.

Species of Mimulus are much different from each other so far as the trichome compliments are concerned. M. nepalensis and M. gracilis resemble each other only in having unicellular conical, unicellular cylindrical, unicellular dentate and peltate glandular hairs. The latter species can be separated by the presence of unicellular papillose hairs and organographic distribution of peltate glandular forms which in this species were recorded only on the vegetative parts, while M. nepalensis shows their presence on both floral and vegetative organs, in addition to unicellular clavate, bicellular filiform, uniseriate conical and unicellular glandular capitate hairs, these forms are observed only in this species of Mimulus. M. luteus, except in having unicellular papillose hairs, differs from the remaining species not only in possessing different forms of hairs like unicellular flagellate, unicellular acuminate, peltate porous glandular, unicellular glandular capitate and bicellular glandular capitate ones but also in their distribution. Nonglandular types were recorded on the floral parts, while glandular forms were observed on both the organs and the presence of unicellular glandular capitate forms on the ovary is a distinctive feature.

Species of Marus have been found to be related to each other in having common uniseriate conical and uniseriate glandular capitate hairs, the latter form is lacking in M. japonicus which can also be delimited from other species by the presence of unicellular cylindrical, unicellular dentate and bicellular glandular capitate trichomes. M. surculosus and M. dentatus show unicellular glandular capitate and uniseriate glandular capitate forms. They differ from each other in uniseriate filiform hairs which are absent in the former and present in the latter. Marus pusillus resembles other species in having uniseriate conical and uniseriate glandular capitate hairs but is quite distinct from others in having unicellular papillose forms. M. japonicus and M. dentatus, differ from others in having unicellular clavate hairs, but these two also differ from each other in glandular trichome complements, the former has bicellular glandular capitate whereas the latter shows the presence of unicellular glandular capitate and uniseriate glandular capitate forms (Tables IX & X).

It is evident from table X that the four species of Lindenbergia investigated have 17 types of nonglandular and only 3 types of glandular hairs. The trichomes which are common to all the 4 species include uniseriate filiform

and uniseriate glandular capitate types from the nonglandular and glandular categories respectively, while the remaining forms are restricted in distribution and are confined to one or two species only. L. macrostachya shows the presence of peltate glandular hairs while unicellular glandular capitate ones were recorded in L. grandiflora and L. indica and uniseriate glandular capitate forms occur in all the species investigated. The species having common glandular hairs can be delimited by the presence of nonglandular hairs which are recorded in one or two species. Uniseriate filiform hairs were observed in all the species. The nonglandular trichomes are of rare occurrence and are specific to particular species of Lindenbergia viz., L. macrostachya (unicellular papillose), L. indica (unicellular aseptate flagellate & uniseriate conical), L. grandiflora (bicellular acuminate & uniseriate acuminate) and L. muraria (uniseriate aseptate flagellate).

Similarly, Stemodia viscosa and Stemodia sufraetiflora have been found closer to each other in having unicellular glandular capitate, bicellular glandular capitate and uniseriate glandular capitate hairs, these could be easily separated on the basis of other trichome compliments. The former shows unicellular flagellate (on corolla), unicellular conical (on stamens) and peltate glandular (on stem) forms,

whereas the latter has uniseriate filiform and uniseriate capitate flagellate types on both vegetative and floral organs.

From the 4 species of Limnophila, two (L. gratioloides and L. chinensis) show equal numbers of nonglandular and glandular hairs (Table X). Remaining species i.e., L. sessiliflora and L. indica though similar in having peltate glandular vesicular and unicellular dentate hairs, but the latter can be separated from the former by the presence of three other nonglandular forms i.e., unicellular flagellate, bicellular filiform and uniseriate hooked forms. L. gratioloides and L. chinensis are related to each other in having uniseriate septate flagellate and peltate porous glandular hairs, but the two can be differentiated from each other forms of hairs. The former has uniseriate conical and bicellular cylindrical types and the latter unicellular flagellate, unicellular conical, unicellular glandular capitate vesicular and bicellular glandular capitate vesicular ones. Each of the 4 species of Limnophila can also be separated from one another on the basis of their specific trichome compliments, which are confined to particular species, i.e., L. sessiliflora (unicellular clavate), L. gratioloides (uniseriate conical and bicellular glandular capitate), L. chinensis (unicellular glandular capitate

vesicular and bicellular glandular capitate vesicular) and L. indica (bicellular filiform and uniseriate hooked). species of Bacopa i.e., B. monnieri and B. procumbens are widely separated on the basis of the types of hairs they possess. B. monnieri shows the presence of uniseriate cylindrical, uniseriate septate flagellate and peltate glandular hairs, while B. procumbens is distinctive in having unicellular clavate and peltate porous glandular types.

The taxa Gratiola officinalis, Dopatrium junceum and Artanema angustifolium although have been found similar in having peltate porous glandular hairs, yet they show marked differences in other forms of hairs (Table X) e.g., Dopatrium junceum is quite distinct from G. officinalis and A. angustifolium in lacking peltate porous glandular type of hairs which are totally absent from all their parts. Further, G. officinalis and A. angustifolium can be separated on the basis of uniseriate glandular capitate type of hairs which are observed only in Artanema angustifolium.

Species of Craterostigma studied, differ not only in quantitative characters of trichomes, but also in qualitative characters e.g., C. plantigena bears 6 types of trichomes which are all nonglandular, while C. pumilum

has 8 types out of which 6 are nonglandular and 2 glandular. Thus, the latter species is easily distinguished from the former with glandular forms. They resemble each other in having unicellular papillose, unicellular clavate and unicellular flagellate hairs.

Similarly, Torenia also shows the presence of more nonglandular hairs than the glandular ones, as revealed from Tables IX & X. Amongst the glandular forms which are common to all the three species (viz., Torenia cordifolia, T. fournieri and T. violacea), are unicellular glandular capitate. Peltate glandular ones are restricted to T. cordifolia and T. violacea, while peltate porous glandular forms are rare and observed in T. fournieri. From the category of nonglandular hairs, the most commonly recorded type is unicellular dentate type followed by unicellular curved (T. cordifolia and T. fournieri), bicellular conical (T. cordifolia and T. violacea) and unicellular dentate (T. fournieri and T. violacea). Hairs which are specific to each species are unicellular hooked, uniseriate conical and uniseriate hooked (T. cordifolia), unicellular papillose (T. fournieri) and unicellular cylindrical, uniseriate filiform and uniseriate septate flagellate (T. violacea²).

Among the species of Lindernia L. crustacea shows the presence of maximum types of trichomes (11 types),

whereas L. ciliata and L. parviflora possess 3 types each. L. ciliata and L. parviflora are related to each other in having unicellular dentate and bicellular glandular capitate hairs but can be distinguished in other forms, peltate glandular in former and unicellular flagellate in the latter, with respect to the latter form of trichomes. They are related to L. crustacea which is distinguished from other two species in having unicellular clavate, unicellular acuminate, unicellular conical, unicellular cylindrical, unicellular curved, bicellular filiform and unicellular glandular capitate forms.

Angelonia grandiflora and A. gardneri are conspicuous by the absence of any type of nonglandular hairs but show the presence of 5 and 4 types of glandular hairs respectively. The relationship between the two species may be established on the basis of peltate porous glandular, bicellular glandular capitate and uniseriate glandular capitate hairs, but should be kept separate from other forms such as A. grandiflora due to the presence of unicellular glandular capitate and uniseriate glandular capitate vesicular hairs and A. gardneri because of uniseriate glandular ones.

Calceolaria mexicana and Calceolaria gracilis share uniseriate filiform and unicellular glandular capitate

trichomes, but can be delimited from one another on the basis of unicellular dentate (C. mexicana) and bicellular filiform and uniseriate glandular (C. gracilis) forms.

Nonglandular trichomes help in establishing distinction among the species of Russelia. R. coccinea is distinguished by the presence of bicellular furcate hairs from the remaining taxa of this series as it is recorded only in this species, in addition to uniseriate cylindrical and uniseriate furcate types. R. floribunda possesses unicellular flagellate and bicellular curved hairs and R. equisetiformis has unicellular conical ones. R. floribunda and R. equisetiformis are related to each other in having unicellular papillose, unicellular hooked, uniseriate filiform, uniseriate conical and peltate porous glandular hairs, but the latter is characterized by the presence of bicellular glandular capitate vesicular forms which are recorded only in this species.

In Nemesia strumosa out of 4 types of hairs only one type is nonglandular (unicellular clavate). The remaining three are glandular types i.e., peltate glandular, unicellular glandular capitate, and bicellular glandular capitate. In respect of the last two forms of hairs, N. strumosa is related to Collinsia bicolor, which is distinct from the former species in having other forms of hairs, i.e., unicellular

papillose, unicellular cylindrical, unicellular dentate and uniseriate glandular capitate forms.

Tables IX and X show organographic and specieswise distribution of trichomes. These tables clearly indicate that majority of trichomes were recorded on almost all parts of the taxa studied, while some trichome types are confined to floral parts and some to vegetative parts only. For example, unicellular clavate, unicellular acerate, bicellular glandular capitate vesicular and uniseriate glandular are located on floral parts only, bicellular acuminate bicellular furcate and unicellular glandular capitate vesicular on vegetative organs, while remaining forms of hairs have been recorded on both.

Some trichome compliments are very characteristic in their distribution, such as peltate glandular, bicellular glandular capitate, uniseriate glandular capitate and uniseriate glandular capitate vesicular types are observed on all the structures of vegetative and floral organs studied.

Some hairs are specific to a particular part and could not be observed on other structures e.g., unicellular clavate on corolla of Linaria vulgaris, Antirrhinum orontium, Mimulus nepalensis, Mimulus dentatus, Lindenbergia grandiflora, Lindenbergia indica, Lindenbergia muraria.

Linnophila sessiliflora, Bacopa procumbens, Lindernia crustacea, Nemesia strumosa, Craterostigma plantigenia and Craterostigma pumilum; bicellular furcate on leaf of Russelia coccinea and unicellular glandular capitate on stem of Linnophila chinensis. Such a type of distribution of these hairs on the specific parts of the taxa mentioned above is taxonomically significant.

Distribution of various trichome types in different species also helps in their delimitation from one another. The species showing the presence of maximum types of trichomes are Lindenbergia glandiflora, Lindenbergia indica and Vandellia mollis (each with 11 types), followed by Russelia floribunda (9 types), Mimulus nepalensis, Adenocnema capitatum, Craterostigma pumilum, Torenia cordifolia, Torenia violacea and Russelia equisetiformis (each with 8 types).

Common trichome types which have been recorded in majority of the species investigated, belong to the glandular category and are invariably uniseriate glandular capitate forms observed in 26 species, followed by unicellular glandular capitate types in 24 species, while the trichomes from the nonglandular category are unicellular papillose and unicellular dentate in 16 species each, followed by unicellular clavate in 15 species out of 52 species studied from the series Antirrhinideae.

Some of the trichome compliments are too specific and recorded only on a single species viz., bicellular aseptate flagellate, bicellular furcate and unicellular glandular capitate vesicular forms in Lindenbergia indica, Russelia coccinea and Linnophila chinensis respectively. These three taxa are widely separated from the remaining species of the series.

Explanation of Plate 50 contd.

Fig. No.	Trichome types	Taken from	
		Plate No.	Fig. No.
21.	Uniseriate hooked	22	208
22.	Uniseriate acuminate	14	102
23.	Uniseriate aseptate flagellate	16	128
24.	Uniseriate septate flagellate	17	148
25.	Uniseriate furcate	16	129
26.	Peltate glandular	11	69
27.	Peltate glandular vesicular	16	137
28.	Peltate porous glandular	22	216
29.	Unicellular glandular capitate	14	104
30.	Unicellular glandular capitate vesicular	18	166
31 & 32	Bicellular glandular capitate	29 & 17	309 & 150
33.	Bicellular glandular capitate vesicular	18	167
34.	Uniseriate glandular	9	34
35 & 36	Uniseriate glandular capitate	13 & 14	35 & 112
37.	Uniseriate glandular capitate vesicular	9	25
38.	Brevicollate glandular	9	29

TOTAL TRICHOME TYPES IN THE SERIES - ANTIRRHINIDEAE

Explanation of the figures of Plate - 50

Fig. No.	Trichome types	Taken from	
		Plate No.	Fig. No.
1.	Unicellular papillose	7	1
2.	Unicellular clavate	14	94
3.	Unicellular flagellate	24	239
4.	Unicellular acerate	16	125
5.	Unicellular acuminate	15	115
6.	Unicellular conical	23	230
7.	Unicellular hooked	11	53
8.	Unicellular cylindrical	8	14
9.	Unicellular curved	8	15
10.	Unicellular dentate	12	78
11.	Bicellular filiform	7	3
12.	Bicellular conical	23	221
13.	Bicellular cylindrical	27	276
14.	Bicellular curved	16	132
15.	Bicellular acuminate	14	100
16.	Bicellular aseptate flagellate	15	117
17.	Bicellular furcate	28	284
18.	Uniseriate filiform	16	127
19.	Uniseriate conical	22	207
20.	Uniseriate cylindrical	7	4

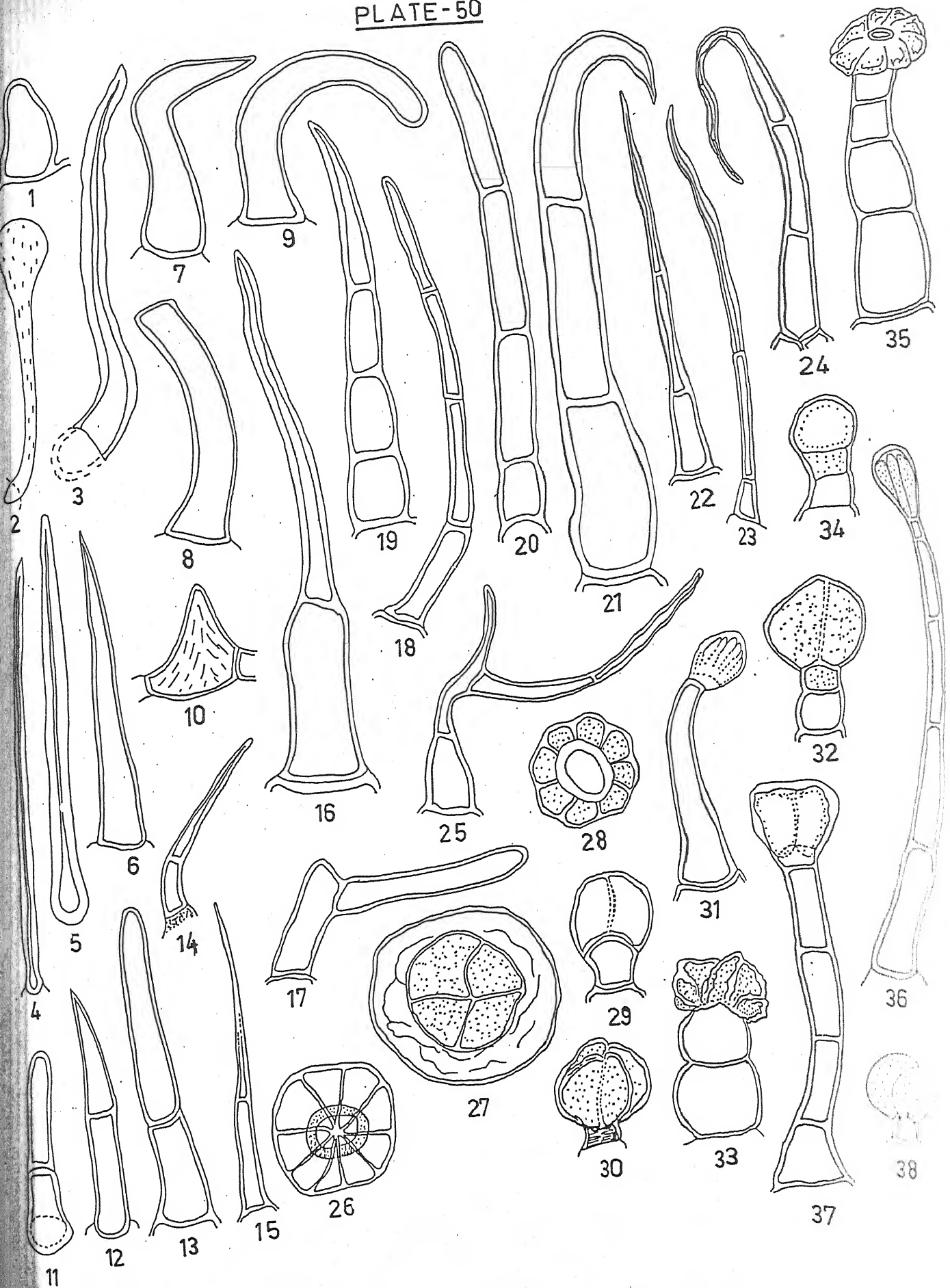


PLATE-50

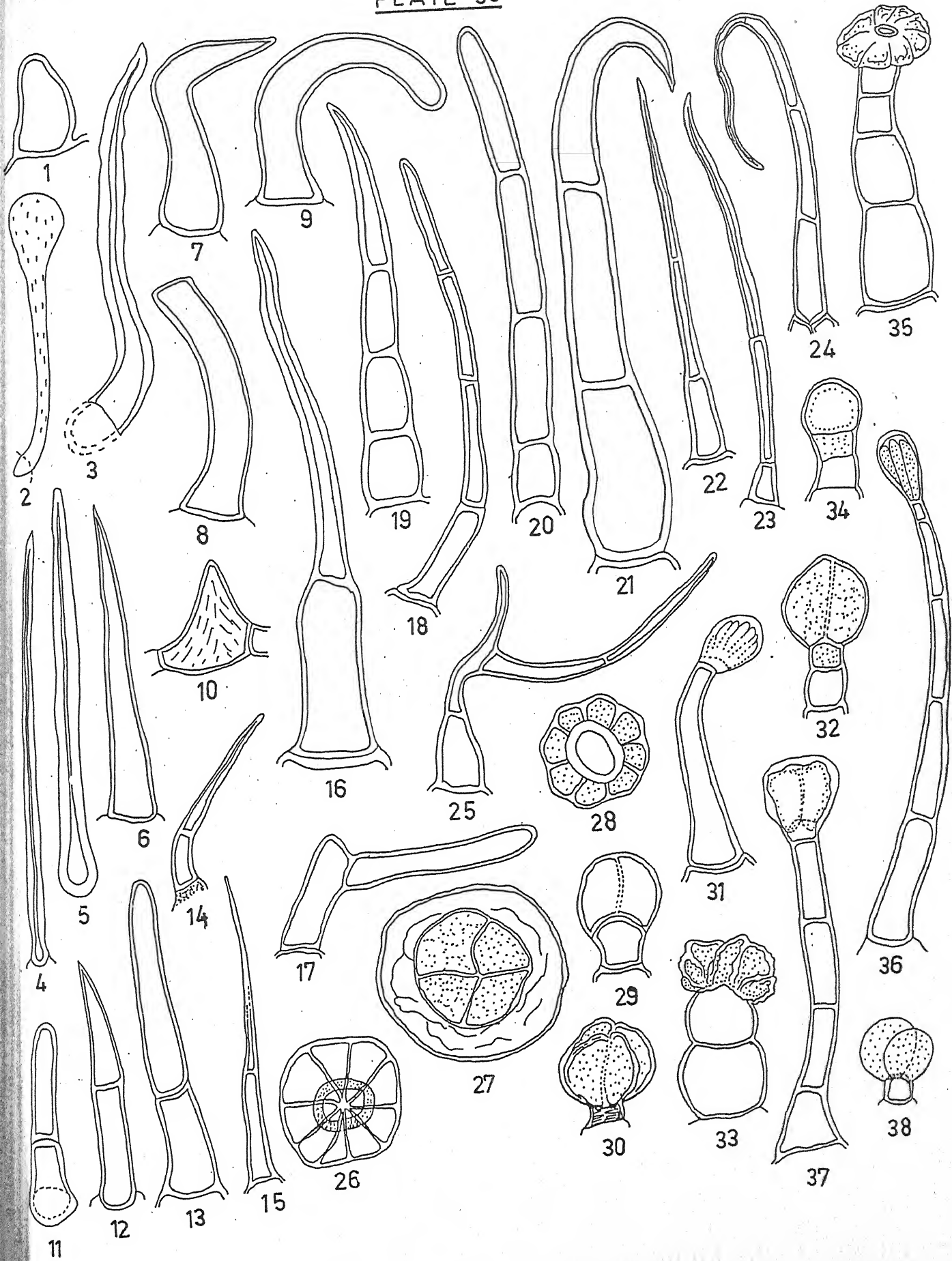


TABLE - VIII : TOTAL TRICHOME TYPES OBSERVED IN THE
SERIES - ANTIRRHINIDEAE

S.No.	Trichome types	Code
	<u>Non glandular</u>	
1.	Unicellular papillose	A ₁
2.	Unicellular clavate	A ₂
3.	Unicellular flagellate	A ₃
4.	Unicellular acerate	A ₅
5.	Unicellular acuminate	A ₆
6.	Unicellular conical	A ₇
7.	Unicellular hooked	A ₈
8.	Unicellular cylindrical	A ₉
9.	Unicellular curved	A ₁₀
10.	Unicellular dentate	A ₁₁
11.	Bicellular filiform	B ₁
12.	Bicellular conical	B ₂
13.	Bicellular cylindrical	B ₃
14.	Bicellular curved	B ₄
15.	Bicellular acuminate	B ₆
16.	Bicellular aseptate flagellate	B ₇
17.	Bicellular furcate	B ₈
18.	Uniseriate filiform	C
19.	Uniseriate conical	D
20.	Uniseriate cylindrical	E

TABLE - IX A : ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES AND THEIR FREQUENCY IN THE TAXA OF THE SERIES - ANTIRRHINIDEAE

Taxa	Stem					Petiole			Leaf lamina		Leaf margin	Inflorescence axis
									Upper	Lower		
<u>Linaria ramosissima</u>	II A ₁	II B ₁	III B ₃	III E	III W	I B ₃	I E	I W	I E	I W	-	-
<u>L. vulgaris</u>			-			-			-	II A ₁₁	I A ₁₁	
<u>Kickxia subsessilis</u>	III A ₉	III B ₃	III C	I T	III W	-			II A ₉	III C	-	-
<u>Antirrhinum orontium</u>	III X					III X			-	-	-	-
<u>A. majus</u>	III X					-			II X	-	II X	III X
<u>Scrophularia calycina</u>	II R	II W				-			II R	II T	III W	-
<u>S. urticaefolia</u>			-			-			III W	III Y	-	-
<u>S. polyantha</u>	III R	III T	II Y			-			III W	III W	-	-
<u>S. decomposita var typica</u>	II R					-			-	I R	II R	-
<u>S. decomposita ssp. latifolia</u>	III T					-			-	I T	III T	-
<u>Sutera glandulosa</u>	I A ₈	III O	II T			-			III O	III O	-	-
<u>Mimulus nepalensis</u>	I D	III O				III D			III O	III A ₇	II D	III O
<u>M. gracilis</u>	III O					-			III O	III O	I A ₁₁	-
<u>M. luteus</u>	III T					-			III O	II O	-	-

TABLE - IX B : ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES AND THEIR FREQUENCY IN TAXA OF THE SERIES - ANTIRRHINIDEAE

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>Linaria ramosissima</u>	-	-	II II III III A ₁ B ₃ E W	II III III II A ₁ B ₃ E W	-	II II A ₁ B ₃	II II II A ₁ B ₁ E
<u>L. vulgaris</u>	-	-	I I II A ₇ R W	II III A ₁ A ₂	II A ₇	-	-
<u>Kickxia subsessilis</u>	-	-	III III III A ₉ B C	I II A ₉ A ₃	-	-	-
<u>Antirrhinum orontium</u>	-	III X	III X	III A ₂	-	III X	III X
<u>A. majus</u>	III X	III X	III III E X	III X	III III A ₁ X	III X	III X
<u>Scrophularia calycina</u>	-	-	II III R T	II II I II R T W Y	III R	-	-
<u>S. urticaefolia</u>	I III W Y	I II T W	III I II I A B ₃ Y V	-	I III II T R W	-	-
<u>S. polyantha</u>	II T	-	-	III T	III W III W	-	-
<u>S. decomposita</u> var. <u>typica</u>	III R	II R	II R	I R	-	-	-
<u>S. decomposita</u> ssp. <u>latifolia</u>	III I U Y	II III III R U Y	II II	-	-	-	-
<u>Sutera glandulosa</u>	-	III O	III O	III O	-	-	III O
<u>Mimulus nepalensis</u>	II II O W	II I O W	-	III III II III A ₂ A ₇ A ₉ A ₁₁ II I B ₁ O	-	-	-
<u>M. gracilis</u>	-	-	III III A ₇ A ₉	III III A ₁ A ₉	-	-	-
<u>M. luteus</u>	III T	III III II A ₃ A ₆ T	I A	-	-	III R	I R

TABLE - IX A contd.

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>Mazus japonicus</u>	II I A ₉ D	-	-	-	-	III III D T
<u>M. surculosus</u>	-	III III D R	II III D R	II D	II D	-
<u>M. dentatus</u>	III III C R	III C	III III D R	III III C R	-	-
<u>M. pumilus</u>	I III D W	-	-	-	I I A ₁ D	III W
<u>Lindenbergia grandiflora</u>	III III III C H W	III III III B ₆ B ₂ C	III II III II B ₆ C H R	III II II III B ₆ B ₂ C H	II B ₂	-
<u>L. macrostachya</u>	-	-	-	-	-	II I III C O W
<u>L. indica</u>	III III III C J W	II III III III III B ₇ C J R W	III III III D J W	III III III C D W	-	-
<u>L. muraria</u>	III III C W	III I III C K W	III III III B ₂ C W	III III C W	III B ₂	-
<u>Adenosma capitatum</u>	III II C P	-	II II II D C P	III D	-	-
<u>Stemodia viscosa</u>	I I III O R W	-	I III III R T W	III W	-	-
<u>S. subfruticosa</u>	III III III III III C J R T W	-	III III I III III C J R T W	III III C J	-	-
<u>Limnophila sessiliflora</u>	III P	-	II P	II P	II A ₁₁	-
<u>L. gratioloides</u>	II Q	-	II Q	II II J Q	III A ₁₁	-

TABLE - IX B contd.

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>Morus japonicus</u>	III III D T	-	III II II A ₂ A ₁₁ T	-	-	-	-
<u>M. surculosus</u>	III III W R	II II W R	I II II D W R	II W	-	-	-
<u>M. dentatus</u>	-	-	III II C W	III A ₂	-	-	-
<u>M. pumilus</u>	III W	-	I D	I A ₁	-	-	-
<u>Lindenbergia grandiflora</u>	-	-	III III III II A ₅ B ₆ H J	III II III III A ₂ A ₅ A ₉ B ₃ III III III III C H J W	II III III A ₅ A ₉ B ₃	III A ₅	III A ₅
<u>L. macrostachya</u>	-	II II II III B ₃ B ₄ C W	III II II A ₉ C W	II II II A ₁ A W	-	-	-
<u>L. indica</u>	III W	III III III C J W	III III III III A ₆ C J W	III III I III A ₂ C K W	II III II I A ₃ B ₇ J W	III II A ₆ B ₄	III III II IX A ₆ B ₄ B ₇ C
<u>L. muraria</u>	III I III A ₅ C W		III III III III III A ₅ B ₂ C I W	III III III A ₂ C W	-	-	-
<u>Adenosma capitatum</u>	-	I III I E J W	III III III B ₄ J P	III A ₃	-	-	-
<u>Stenodia viscosa</u>	II III T W	III W	III III T W	III III A ₃ W	II A ₇	-	-
<u>S. subfruticosa</u>	III II II C R W	-	III III I II C J T W	I III T W	-	-	-
<u>Limnophila sessiliflora</u>	-	II II A ₁₁ ^P	II II A ₇ P	III II A ₂ P	-	-	-
<u>L. gratioloides</u>	-	II J	II III II D A ₁₁ T	III A ₃	-	-	-

TABLE - IX A contd.

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>L. chinensis</u>	II III II J O S	-	III O	III O	II A ₇	-
<u>L. indica</u>	I B ₃	-	III P	III P	III A ₁₁	-
<u>Bacopa monnieri</u>	III O	-	III O	III O	-	-
<u>B. procumbens</u>	III O	-	I O	III O	-	-
<u>Gratiola officinalis</u>	III O	-	I O	III O	-	-
<u>Depatrium junceum</u>	-	-	-	III O	-	-
<u>Artanema angustifolium</u>	II III A ₁₁ O	-	-	III O	III A ₁₁	-
<u>Craterostigma plantigena</u>	-	I I A ₇ A ₆	III III A ₇ A ₉	III III A ₇ A ₉	-	III III A ₇ A ₉
<u>C. punilum</u>	-	-	III A ₁₀	III A ₁₀	III III A ₁₀ A ₁₁	III II A ₁₀ A ₃
<u>Torenia cordifolia</u>	II II II D G O	I III III A ₁ D O	II II III D G O	II III D O	III I A ₁₁ A ₃	-
<u>T. fourneiri</u>	II O	II O	II O	II O	I II A ₁₁ A ₇	-
<u>T. violacea</u>	III III III C I O	II III C O	III O	III O	III III II A ₁₁ B ₂ C	-
<u>Vandellia mollis</u>	II III III II III A ₃ A ₆ B ₆ H O	III O	II III A ₇ O	III III II III A ₆ A ₇ A ₈ B ₆	III A ₇	-

TABLE - IX B contd.

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>L. chinensis</u>	I U	II III A ₇ Q	-	III II A ₃ U	II A ₃	-	-
<u>L. indica</u>	-	-	III P	III A ₃	-	-	-
<u>Bacopa monnieri</u>	-	III O	III III A ₉ O	III I A ₉ J	-	-	-
<u>B. procumbens</u>	II O	II O	III O	II A ₂	-	-	-
<u>Gratiola officinalis</u>	III O	III O	III II III O R T	-	-	-	-
<u>Depatrium junceum</u>	-	-	-	II A ₉	II A ₉	-	-
<u>Artanema angustifolium</u>	III A ₁₁	-	III II A ₁₁ O	I III III II A ₁ Q T W	-	-	-
<u>Craterostigma platigena</u>	-	III I II A ₇ A ₃ A ₉	III I II II A ₇ A ₃ A ₆ A ₉	III III A ₁ A ₂	-	III II A ₂ A ₉	-
<u>G. pumilum</u>	-	III I A ₁₀ A ₈	III A ₁₀	II II I A ₂ R W	-	III A ₁	-
<u>Torenia cordifolia</u>	III II III D G O	-	I II II B ₂ D O	II O	III R	-	-
<u>T. fourneiri</u>	I II A ₇ O	I II A ₇ O	II I II A ₇ A ₁₀ O	III III II A ₃ O R	-	III II A ₁ A ₁₁	II A ₁₁
<u>T. violacea</u>	II II III C I O	III III II I A ₁₁ B ₂ C I	III II III B ₂ C O	II II A ₉ R	I R	III A ₇	III A ₇
<u>Vandellia mollis</u>	III III II III III A ₃ A ₆ A ₈ O T	-	III II II III A ₆ A ₇ A ₈ O	III III A ₁ V	-	II A ₁	-

TABLE - IX A contd.

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>Lindernia crustacea</u>	II I I III A ₁₀ A ₃ B ₁ O	III O	I III B ₁ O	III A ₇	III A ₁₁	-
<u>L. ciliata</u>	II III A ₁₁ O	-	II III A ₁₁ O	II III A ₁₁ O	-	-
<u>L. parviflora</u>	-	-	-	-	II A ₁₁	-
<u>Angelonia grandiflora</u>	III X	-	II III O X	III III O X	III X	-
<u>A. gardeneri</u>	III W	-	II III O W	II III O W	III W	-
<u>Calceolaria mexicana</u>	III III C W	-	III W	III W	III W	-
<u>C. gracilis</u>	II II III B ₁ C W	-	III W	III W	-	-
<u>Russelia equisetiformis</u>	III II III II A ₁ B ₃ C D	-	III II I III A ₇ B ₃ D O	II III A ₇ O	I I A ₈ C	-
<u>R. coccinia</u>	III I III I III A ₉ B ₃ E K R	-	-	-	II I I III A ₉ B ₃ B ₈ E I III K R	-
<u>R. floribunda</u>	I O	-	III III I A ₃ O R	III III A ₃ O	-	-
<u>Collinsia bicolor</u>	III A ₉	-	-	-	-	-
<u>Nemesia strumosa</u>	II O	-	II O	II O	-	-

I = scarce; II = frequent; III = abundant

TABLE - IX B contd.

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>Lindernia crustacea</u>	I III B ₁ O	-	III II I III A ₆ A ₁₁ B ₁ O	III II III I A ₂ O R T	II II III A ₉ O R	-	-
<u>L. ciliata</u>	-	II III A ₁₁ O	II III A ₁₁ O	II T	-	-	-
<u>L. parviflora</u>	II T	-	II II A ₃ T	I T	-	-	-
<u>Angelonia grandiflora</u>	III X	-	III III T X	III R	III W	III W	II III R W
<u>A. gardeneri</u>	II III O W	-	II III O W	I III T W	III W	III W	I II T W
<u>Calceolaria mexicana</u>	-	III W	I II A ₁₁ W	III W	-	-	-
<u>C. gracilis</u>	-	III W	III W	III V	-	-	II W
<u>Russelia equisetiformis</u>	-	III II A ₈ B ₃	III U	III U	-	-	-
<u>R. coccinea</u>	-	-	III R	III W	II W	-	-
<u>R. floribunda</u>	III III III II III A ₁ A ₃ A ₈ C D	III II A ₁ A ₈	I III I A ₁ A ₈ R	III III A ₉ R	-	-	-
<u>Collinsia bicolor</u>	-	-	II III II III I A ₉ A ₁₁ A ₇ T W	II R	-	-	-
<u>Nemesia strumosa</u>	III T	-	II T	III III II A ₂ O T	III R	-	-

I = scarce; II = frequent; III = abundant

TABLE - X A : SPECIESWISE DISTRIBUTION OF TRICHOMES IN THE SERIES - ANTIRRHINIDEAE

Trichome types	Code	TAXA NOS.																															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Unicellular papillose	A ₁	+	+			+		+						+	+					+		+											
Unicellular clavate	A ₂		+		+							+				+		+		+		+	+					+					
Unicellular flagellate	A ₃			+											+						+			+	+					+	+		
Unicellular acerate	A ₅																			+			+										
Unicellular acuminate	A ₆														+							+											
Unicellular conical	A ₇		+										+	+											+		+		+				
Unicellular hooked	A ₈											+																					
Unicellular cylindrical	A ₉			+									+	+		+					+	+											
Unicellular curved	A ₁₀			+																													
Unicellular dentate	A ₁₁		+										+	+		+												+				+	
Bicellular filiform	B ₁	+											+																			+	
Bicellular conical	B ₂																			+			+										
Bicellular cylindrical	B ₃	+		+				+												+	+												
Bicellular curved	B ₄																				+	+			+								
Bicellular acuminate	B ₆																			+													
Bicellular aseptate flagellate	B ₇																					+											
Bicellular furcate	B ₈																																
Uniseriate filiform	C			+															+		+	+	+	+	+		+						

TABLE - X A : contd.

Trichome type	Code	TAXA NOS.																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Uniseriate conical	D											+			+	+	+	+			+		+						+			
Uniseriate cylindrical	E	+				+																		+								+
Uniseriate hooked	G																															+
Uniseriate acuminate	H																			+												
Uniseriate aseptate flagellate	I																						+									
Uniseriate septate flagellate	J																			+		+		+		+		+	+		+	
Uniseriate furcate	K																					+	+									
Peltate glandular	O											+	+	+							+					+						+
Peltate glandular vesicular	P																							+			+				+	
Peltate porous glandular	Q														+														+	+		
Unicellular glandular capitate	R		+				+	+	+	+	+				+		+	+		+		+			+	+						
Unicellular glandular capitate vesicular	S																													+		
Bicellular glandular capitate	T			+			+	+	+		+				+	+										+	+		+			
Bicellular glandular capitate vesicular	U										+																			+		
Uniseriate glandular	V							+																								
Uniseriate glandular capitate	W	+	+	+			+	+	+	+		+					+	+	+	+	+	+	+	+	+	+						
Uniseriate glandular capitate vesicular	X				+	+																										
Brevicollate glandular capitate	Y						+	+	+		+																					
Number of types of trichome per species		5	6	7	2	3	4	7	4	2	4	3	8	5	6	5	3	5	3	11	7	11	7	8	6	5	4	4	6	5	3	

TABLE - X B : SPECIESWISE DISTRIBUTION OF TRICHOMES IN THE SERIES - ANTIRRHINIDEAE

Trichome type	Code	TAXA NOS.																				No. of species	
		32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51		52
Unicellular papillose	A ₁			+	+	+		+		+								+		+	+		16
Unicellular clavate	A ₂	+				+	+				+											+	15
Unicellular flagellate	A ₃					+	+			+	+		+							+			14
Unicellular acerate	A ₅																						2
Unicellular acuminate	A ₆					+					+	+											5
Unicellular conical	A ₇					+				+	+	+	+					+					12
Unicellular hooked	A ₈						+	+			+							+		+			6
Unicellular cylindrical	A ₉		+			+				+		+							+	+	+		13
Unicellular curved	A ₁₀						+	+	+		+	+											6
Unicellular dentate	A ₁₁			+			+	+	+	+		+	+	+			+				+		16
Bicellular filiform	B ₁										+							+					5
Bicellular conical	B ₂							+		+													4
Bicellular cylindrical	B ₃																	+	+				7
Bicellular curved	B ₄																			+			4
Bicellular acuminate	B ₆										+												2
Bicellular aseptate flagellate	B ₇																						1
Bicellular furcate	B ₈																			+			1
Uniseriate filiform	C									+						+	+	+		+			13

TABLE - X B contd.

Trichome type	Code	TAXA NOS.																				No. species
		32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51		52
Uniseriate conical	D						+											+		+		11
Uniseriate cylindrical	E																		+			5
Uniseriate hooked	G						+															2
Uniseriate acuminate	H								+													2
Uniseriate aseptate flagellate	I							+														2
Uniseriate septate flagellate	J																					7
Uniseriate furcate	K																		+			3
Peltate glandular	O						+		+	+	+	+									+	12
Peltate glandular vesicular	P																					3
Peltate porous glandular	Q	+	+	+				+					+	+				+		+		12
Unicellular glandular capitate	R	+				+	+	+	+		+		+						+	+	+	24
Unicellular glandular capitate vesicular	S																					1
Bicellular glandular capitate	T	+		+					+	+	+	+	+	+						+	+	21
Bicellular glandular capitate vesicular	U																	+				3
Uniseriate glandular	V								+					+			+					4
Uniseriate glandular capitate	W			+		+				+			+	+	+	+		+		+		26
Uniseriate glandular capitate vesicular	X												+									3
Brevicellate glandular capitate	Y																					4
Number of types of trichome per species		4	2	5	6	8	8	7	8	11	11	3	3	5	4	3	4	8	7	9	6	4

TABLE - XI A : DISTRIBUTION OF TRICHOMES ON DIFFERENT PARTS IN THE TAXA OF SERIES - ANTIRRHINIDEAE

Organs	Trichome types (Non glandular)																			
	A ₁	A ₂	A ₃	A ₅	A ₆	A ₇	A ₈	A ₉	A ₁₀	A ₁₁	B ₁	B ₂	B ₃	B ₄	B ₆	B ₇	B ₈	C	D	E
Stem	+		+		+		+	+	+	+	+		+		+			+	+	+
Leaf	+		+			+	+	+	+	+	+	+	+		+	+	+	+	+	+
Inflorescence axis																		+	+	
Pediceal	+		+	+	+	+	+			+	+							+	+	
Bract/ Bracteole	+					+	+			+		+	+	+				+		+
Calyx	+		+	+	+	+	+	+	+	+	+	+	+	+				+	+	+
Corolla	+	+	+	+		+		+		+	+		+					+		+
Stamen	+		+	+		+		+					+				+			
Carpel	+			+	+	+				+	+		+	+			+	+		+

+ = Presence

TABLE - XI B : DISTRIBUTION OF TRICHOMES ON DIFFERENT PARTS IN THE TAXA OF SERIES - ANTIRRHINIDEAE

Organs	Trichome types																Total No. of types of tri- chomes
	Non glandular					Glandular											
	G	H	I	J	K	O	P	Q	R	S	T	U	V	W	X	Y	
Stem	+	+	+	+	+	+	+	+	+	+	+			+	+		26
Leaf	+	+		+	+	+	+	+	+		+			+	+	+	28
Inflorescence axis						+					+			+	+		6
Pedicel	+		+	+		+	+	+	+		+	+		+	+	+	12
Bract/ Bracteole			+	+		+	+	+	+		+	+		+	+	+	20
Calyx		+	+	+		+	+	+	+		+	+	+	+	+	+	29
Corolla		+		+	+	+		+	+		+	+	+	+	+	+	23
Stamen				+		+			+		+		+	+	+	+	15
Carpel						+			+		+			+	+		16

+ = Presence

(c) SERIES - RHINANTHIDEAE

The series Rhinanthideae is placed next to Antirrhinideae on the basis of its size. It consists of 3 tribes i.e., Digitalaceae, Cerardiaceae and Euphrasieae. It shows the presence of 34 types of both nonglandular and glandular trichomes which are distributed to 39 species belonging to 12 genera.

In nonglandular category of trichomes, 10 types of unicellular (i.e., papillose, clavate, flagellate, filiform, acerate, acuminate, conical, hooked, curved and dentate), 7 types of bicellular (i.e., filiform, conical, cylindrical, curved, hooked, acuminate and aseptate flagellate) and 8 types of uniseriate (i.e., filiform, conical, cylindrical, curved, hooked, acuminate, aseptate flagellate and septate flagellate) were recorded. Among the uniseriate ones, filiform and septate flagellate types were observed on all parts of the species studied. The former types were recorded in 21 species, while the latter in 17 species. Some types were observed on the specific plant parts such as unicellular filiform types on stamens, bicellular

acuminate on leaves, and uniseriate acuminate on stem. A few were recorded only on vegetative parts e.g., bicellular filiform, bicellular acuminate and uniseriate acuminate types. Some forms were found confined to floral parts, e.g., unicellular clavate, unicellular filiform and uniseriate aseptate flagellate ones, while the remaining types were found distributed on both the organs.

The trichomes recorded from the glandular category were found to be of 2 types of peltate (i.e., peltate glandular and peltate porous glandular), 1 of unicelled (unicellular glandular capitate), 2 bicelled (bicellular glandular capitate and bicellular glandular capitate vesicular), 3 types of uniseriate (uniseriate glandular, uniseriate glandular capitate and uniseriate glandular capitate vesicular), and brevicollate glandular capitate ones. Uniseriate glandular forms were recorded on all parts of the species studied, while uniseriate glandular capitate vesicular and brevicollate glandular capitate were observed only on the floral parts and the remaining forms have been observed on both the organs. Unicellular glandular capitate is most common type from this category as it is represented in 24 species (Tables XIII and XIV).

Some of the trichome types of both the categories are very rare in distribution and were recorded in lone representatives viz., unicellular clavate (Digitaria purpurea), unicellular filiform (Veronica acrocladia), unicellular acerate (Scoparia trifida), unicellular curved (Veronica biloba), bicellular acuminate (Alectra parasitica var. chitrakutensis), uniseriate acuminate (Striga orobanchoides), uniseriate septate flagellate (Euphrasia laxa), peltate porous glandular (Scoparia dulcis), and bicellular glandular capitate vesicular (Euphrasia officinalis). Thus, the particular trichomes become taxonomic markers for the respective species.

Hemiphragma heterophyllum and Mulgenia antarctica are related to each other and to some other taxa as well, in having uniseriate glandular capitate hairs, but differ in other forms, the former in possessing uniseriate filiform, uniseriate conical and peltate glandular ones and the latter with uniseriate curved, uniseriate septate flagellate and unicellular glandular capitate ones.

Eleven species of the genus Veronica showed 17 types of trichomes, 13 nonglandular and 4 glandular ones. Some trichomes were common to most of the species while others were either not so common or restricted in their distribution and were recorded in one or a few species.

For example, unicellular glandular capitate type was most common and had been recorded in 9 species, while it was absent in Veronica anagallis aquatica and V. agrestis. The former species showed only uniseriate glandular hairs, which were also shared by V. arvensis, V. serpyllifolia and V. undulata. V. agrestis is characterized by the total absence of glandular hairs. The species show similarities on the basis of one or more common type of hairs and can be distinguished on the basis of other forms. Uniseriate conical is the common type of trichome and is universally present in V. persica, V. biloba, V. verna, V. arvensis, V. serpyllifolia and V. eriocarpa, uniseriate filiform in V. persica, V. biloba, V. arvensis, V. serpyllifolia, V. eriocarpa and V. mellissaeifolia.

Veronica persica and V. biloba may be distinguished from each other on the basis of unicellular hooked and uniseriate hooked trichomes in the former, and bicellular curved in the latter. In addition to the aforesaid trichomes, V. verna and V. arvensis are also related to each other in having, bicellular conical and uniseriate curved hairs. V. arvensis is characterized by uniseriate filiform, uniseriate septate flagellate and uniseriate glandular hairs. V. serpyllifolia, though resembles other species in various forms of hairs, but is

taxonomically distinct from remaining ones in having bicellular glandular capitate hairs. V. undulata shows affinity with V. sarkyillifolia but can be distinguished in organographic distribution i.e., the presence of uniseriate glandular hairs on ovary in the former. V. eriocarpa and V. mellissaeifolia show similarities in uniseriate filiform, uniseriate septate flagellate and unicellular glandular capitate hairs, but they can be separated apart by the presence of uniseriate conical types in the former and unicellular papillose and uniseriate curved ones in the latter.

Digitalis is the most important medicinal plant of the family. Two of its species were studied each showed 5 types of hairs. D. purpurea showed 2 types of nonglandular and 3 types of glandular while D. ^alanata showed 3 and 2 types respectively. Kraemer (1912) described variations in the hairs of the species of Digitalis. The aforesaid two species are similar in having uniseriate filiform and uniseriate glandular capitate hairs, though these hairs have different patterns of distribution and frequency (Table XIII). However, they are distinct in unicellular clavate, bicellular glandular capitate and uniseriate, glandular forms in D. purpurea and uniseriate cylindrical, uniseriate hooked and unicellular glandular capitate in D. lanata. Two of

the three studied species of Alectra viz., A. indica, A. sessiliflora, share unicellular glandular capitate hairs but can be separated by some other forms which are recorded only in particular species, i.e., unicellular conical, unicellular hooked, bicellular filiform, bicellular conical and bicellular curved in A. indica, and uniseriate filiform and uniseriate curved in A. sessiliflora. Alectra parasitica var. chitrakutensis can be distinguished from other species by the presence of uniseriate glandular capitate hairs.

Buchnera resembles Striga in having unicellular hooked and bicellular aseptate flagellate hairs confirming their placement alongwith Alectra which also shares the same combination of hairs in the sub-tribe Buchneraceae of the tribe Gerardiaceae (Hooker, 1885). Trichomes of B. hispida (i.e., uniseriate filiform and unicellular glandular capitate) were not observed in the species of Striga studied. Species of Striga are similar in some forms of hairs but can be distinguished from each other in the presence of other types of hairs, viz., S. orobanchoides in uniseriate acuminate and bicellular glandular capitate, S. lutea in unicellular acuminate and uniseriate conical and S. euphrasioides in unicellular hooked, bicellular cylindrical, bicellular hooked, peltate glandular and peltate glandular vesicular hairs.

Trichome studies have revealed that the species of Euphrasia are quite different from one another except in having common, unicellular conical and uniseriate glandular capitate hairs which are shared by E. lam and E. jaceschkei. They can, however, be distinguished by the presence of other forms i.e., unicellular acuminate, unicellular dentate, bicellular filiform, uniseriate curved and uniseriate aseptate flagellate in the former and bicellular aseptate flagellate, uniseriate septate flagellate and bicellular glandular capitate in the latter. Bicellular cylindrical, unicellular glandular capitate, bicellular glandular capitate vesicular and brevicollate glandular capitate hairs which are present only in one species of Euphrasia i.e., E. officinalis show their taxonomic importance in delimiting it from other species.

Ten species of Pedicularis have been studied in the present investigation. Some trichomic forms are recorded in majority of these species, for example, uniseriate filiform hairs have been found common to all the studied species (except P. verticillata) uniseriate septate flagellate in 8 species (except P. pectinata var. typica and P. bifida) and unicellular glandular capitate in 7 species (except P. brevifolia, P. pyramidata and P. plantaginifolia). Unicellular and bicellular nonglandular hairs are rare and observed only

in 2 or 3 species i.e., unicellular papillose in P. pectinata ssp. bipinnatifida, P. verticillata and P. pyramidata and bicellular hooked in P. oderi. P. verticillata can be distinguished from P. pectinata ssp. bipinnatifida and P. pyramidata in having uniseriate conical and uniseriate glandular capitate hairs. These three species of Pedicularis can further be separated on the basis of organographic distribution of unicellular papillose hairs, in P. pectinata ssp. bipinnatifida it is recorded on surface of leaf and leaf margin, in P. pyramidata on lower surface of the leaf and in P. verticillata they are present on the floral parts. Other remaining species of Pedicularis which also share common types of trichomes may be separated on the basis of their organographic distribution. For example, some species show presence of trichomes on the reproductive organs such as stamens i.e., P. pectinata ssp. bipinnatifida (uniseriate filiform and uniseriate septate flagellate), P. pectinata var. typica (unicellular glandular capitate), P. asplenifolia (uniseriate aseptate flagellate), P. pyramidata (uniseriate cylindrical) and P. brevifolia and P. oderi (uniseriate filiform). P. brevifolia can be distinguished from P. oderi in bicellular glandular capitate hairs on corolla. The latter species is characterized by showing unicellular glandular capitate types on both floral as well as vegetative organs. The abundant occurrence of uniseriate curved

trichomes on the inflorescence axis also provide a taxonomic delimitation of P. asplenifolia from all the studied taxa of the genus Pedicularis (Table XIII).

The taxa which show maximum types of trichomes are Veronica persica, V. biloba and V. serpyllifolia (9 types in each), Alectra indica, Strica euphrasioides, Sorubia delphinifolia and Pedicularis verticillata (8 types in each), Veronica arvensis, Sorubia trifida, Centranthera nepalensis and Euphrasia laxa (7 types in each). Two species of Veronica, V. anagallis-aquatica and V. boeckabunga show only one type of trichome i.e., uniseriate glandular and unicellular glandular capitate respectively, thus showing their isolated position in Veronica complex.

Explanation of Plate 51 contd.

Fig. No.	Trichome types	Taken from	
		Plate No.	Fig. No.
21.	Uniseriate curved	46	189
22.	Uniseriate hooked	31	22
23.	Uniseriate acuminate	39	114
24.	Uniseriate aseptate flagellate	43	160
25.	Uniseriate septate flagellate	33	48
26.	Peltate glandular	40	126
27.	Peltate porous glandular	30	6
28.	Unicellular glandular capitate	46	191
29.	Bicellular glandular capitate	47	207
30.	Bicellular glandular capitate vesicular	43	153
31.	Uniseriate glandular	36	76
32.	Uniseriate glandular capitate	36	77
33.	Uniseriate glandular capitate vesicular	42	142
34.	Brevicollate glandular capitate	43	154

TOTAL TRICHOME TYPES IN THE SERIES - RHINANTHIDEAE

Explanation of the figures of Plate - 51

Fig. No.	Trichome types	Taken from	
		Plate No.	Fig. No.
1.	Unicellular papillose	32	27
2.	Unicellular clavate	36	73
3.	Unicellular flagellate	42	143
4.	Unicellular filiform	31	14
5.	Unicellular acerate	42	145
6.	Unicellular acuminate	40	118
7.	Unicellular conical	36	84
8.	Unicellular hooked	36	85
9.	Unicellular curved	32	28
10.	Unicellular dentate	41	130
11.	Bicellular filiform	37	86
12.	Bicellular conical	31	18
13.	Bicellular cylindrical	43	151
14.	Bicellular curved	32	30
15.	Bicellular hooked	42	147
16.	Bicellular acuminate	37	93
17.	Bicellular aseptate flagellate	39	113
18.	Uniseriate filiform	32	31
19.	Uniseriate conical	40	119
20.	Uniseriate cylindrical	34	55

PLATE- 51

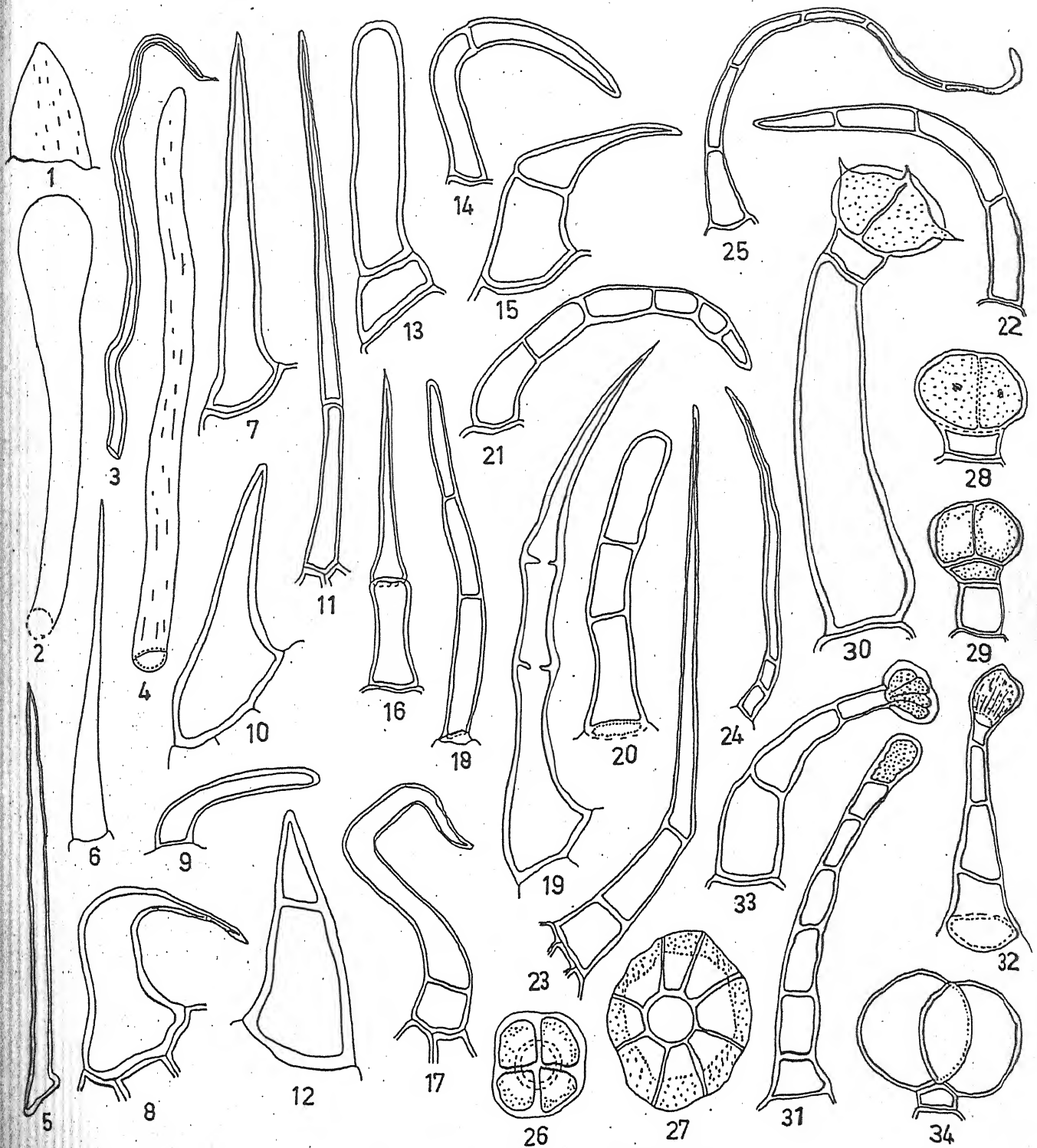


TABLE - XII : TOTAL TRICHOME TYPES OBSERVED IN THE
SERIES - RHINANTHIDEAE

S.No.	Trichome types	Code
	<u>Nonglandular</u>	
1.	Unicellular papillose	A ₁
2.	Unicellular clavate	A ₂
3.	Unicellular flagellate	A ₃
4.	Unicellular filiform	A ₄
5.	Unicellular acerate	A ₅
6.	Unicellular acuminate	A ₆
7.	Unicellular conical	A ₇
8.	Unicellular hooked	A ₈
9.	Unicellular curved	A ₁₀
10.	Unicellular dentate	A ₁₁
11.	Bicellular filiform	B ₁
12.	Bicellular conical	B ₂
13.	Bicellular cylindrical	B ₃
14.	Bicellular curved	B ₄
15.	Bicellular hooked	B ₅
16.	Bicellular acuminate	B ₆
17.	Bicellular aseptate flagellate	B ₇
18.	Uniseriate filiform	C
19.	Uniseriate conical	D
20.	Uniseriate cylindrical	E

Table - XII contd.

S.No.	Trichome types	Code
21.	Uniseriate curved	F
22.	Uniseriate hooked	G
23.	Uniseriate acuminate	H
24.	Uniseriate aseptate flagellate	I
25.	Uniseriate septate flagellate	J
	<u>Glandular</u>	
26.	Peltate glandular	O
27.	Peltate porous glandular	Q
28.	Unicellular glandular capitate	R
29.	Bicellular glandular capitate	T
30.	Bicellular glandular capitate vesicular	U
31.	Uniseriate glandular	V
32.	Uniseriate glandular capitate	W
33.	Uniseriate glandular capitate vesicular	X
34.	Brevicollate glandular capitate	Y

TABLE - XIII A : ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES AND THEIR FREQUENCY IN THE TAXA OF THE SERIES - RHINANTHODEAE

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>Hemiphragma heterophyllum</u>	-	-	II III D O	I III III III C D O W	III III D W	-
<u>Scoparia dulcis</u>	I III A O	III O	III O	III O	-	-
<u>Wulfenia amherstiana</u>	-	II III J R	II III J R	II III J R	-	II III III II P J R W
<u>Veronica anagalis aquatica</u>	-	-	-	-	-	-
<u>V. beccabunga</u>	-	-	III R	III R	-	II R
<u>V. agrestis</u>	-	-	-	-	-	-
<u>V. persica</u>	III III II II A ₃ B ₄ C D III III G R	-	III III D R	III D	III III B ₂ D	-
<u>V. piloba</u>	II II C R	-	II III B ₂ W	II II III B ₂ R W	I II A ₁ W	III II II II II B ₄ C P R W
<u>V. verba</u>	II II F R	-	II R	II D	II II B ₂ D	-
<u>V. arvensis</u>	I III III III C F J R	-	III III C R	III R	III D	-
<u>V. serpyllifolia</u>	III II I II I A ₁ F J R V	-	II II II II I E F J R V	II R	I V	-
<u>V. undulata</u>	III V	-	II V	I II R V	-	III V
<u>V. eriocarpa</u>	I J	-	III C	III C	III I C D	-
<u>V. mellissaeifolia</u>	III III III C R J	-	III III C R	III C	III C	-

TABLE - XIII B : ORGANOGRAPHIC DISTRIBUTION OF TRICHOMES AND THEIR FREQUENCY IN THE TAXA OF THE SERIES - RHINANTHEDEAE

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>Memphragma heterophyllum</u>	-	-	-	-	-	-	-
<u>Scoparia dulcis</u>	-	-	III O	-	-	-	-
<u>Wulfenia amherstiana</u>	-	II III II J R W	II II J W	-	-	-	-
<u>Veronica angalis aquatica</u>	III V	II V	II V	-	-	-	I V
<u>V. heugabunga</u>	-	III R	III R	-	-	-	-
<u>V. arestis</u>	-	-	-	III III A ₁ A ₇	III III A ₁ A ₄	-	-
<u>V. persica</u>	III II III A ₈ B ₄ G	-	II II III I B ₂ C D R	I E	-	-	III III J R
<u>V. biloba</u>	III III III A ₁₀ B ₄ F	-	III II II II III B ₄ D F R W	III III III A ₁₀ D W	-	-	-
<u>V. verna</u>	II II III F R W	II III R W	III II II III B ₂ D R W	II R	-	-	I III D W
<u>V. arvensis</u>	III III III II III C F J R V	I V	II I III II B ₂ D R V	-	-	-	III V
<u>V. serpyllifolia</u>	II II II C E F	II II III R T V	II I I II III C D R T V	I V	-	II A ₁	-
<u>V. undulata</u>	III V	II V	II III R V	II V	-	-	II V
<u>V. eriocarpa</u>	-	II II C R	III II C R	-	-	-	II C
<u>V. mellisaefolia</u>	-	II III III C F R	-	III II A ₁ C	-	-	III C

TABLE - XIII A Contd.

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>Digitalis purpurea</u>	-	-	I †	-	-	-
<u>D. lanata</u>	III III C W	-	II II C W	-	II II C W	-
<u>Alectra indica</u>	II III B ₁ J	-	I I B ₄ R	-	I A ₈	-
<u>A. parasitica</u> var. <u>chitrakutensis</u>	II II A ₆ B ₇	-	I B ₇	-	II I B ₇ B ₆	-
<u>Alectra sessiliflora</u>	-	-	-	-	-	-
<u>Buchnera hispida</u>	III III I A ₈ B ₇ C	-	I R	III B ₇	III III A ₈ B ₇	-
<u>Striga orobanchoides</u>	II III II I II A ₃ A ₇ B ₇ H T	-	III II A ₇ B ₇	III T	III A ₇	-
<u>S. lutea</u>	III A ₃	-	III A ₃	-	III A ₃	II A ₃
<u>S. euphrasioides</u>	III II A ₇ A ₈	-	III III II A ₇ A ₈ O	-	-	-
<u>Centronthera nepalensis</u>	-	-	II B ₅	III III A ₇ B ₅	III III II III A ₇ A ₁₁ C B ₅	III II III B ₅ C R
<u>Sopubia delphinifolia</u>	II III II A ₁ B ₂ D	-	I A ₈	-	-	-
<u>S. trifida</u>	III III B ₄ B ₅	-	I II I I A ₃ B ₄ B ₅ T	-	I III II I A ₃ A ₁₁ B ₄ B ₅	-

TABLE - XIII B contd.

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>Digitalis purpurea</u>	-	III W	I III C W	III III A ₂ W	III III A ₂ V	II II C W	III W
<u>D. lanata</u>	III II II II E G R W	-	II II E W	-	-	-	II W
<u>Alectra indica</u>	-	II III II III A ₇ B ₂ J R	III II III B ₂ J R	III III A ₁ R	II A ₃	-	-
<u>A. parasitica</u> var <u>chitrakutensis</u>	-	II III II A ₆ B ₇ J	III II III B ₇ J W	III W	-	-	-
<u>Alectra sessiliflora</u>	-	I I C R	II II III B ₇ C R	III R	III A ₃	II R	-
<u>Buchnera hispida</u>	-	-	III II A ₈ B ₇	-	-	-	-
<u>Striga orobanchoides</u>	-	III I A ₇ B ₇	III II A ₇ T	III II I II A ₁ A ₃ A ₇ T	-	-	-
<u>S. lutea</u>	-	-	II I A ₃ D	II II A ₁ A ₆	III A ₃	-	-
<u>S. euphrasioides</u>	-	II II II I A ₇ A ₈ B ₅ O	III II II A ₇ A ₈ O	II II II A ₃ B ₃ X	III II A ₃ B ₅	-	-
<u>Centranthera nepalensis</u>	II III III B ₅ C R	III III III III A ₁₁ B ₅ C R	III III III III A ₁₁ B ₇ R B ₅	II A ₃	-	-	-
<u>Sopubia delphinifolia</u>	III II A ₁ B ₂	II II I I A ₁ B ₂ B ₇ R	II II A ₆ B ₇	I II II I III A ₈ B ₂ B ₇ D X	III III D X	II II A ₁ B ₂	-
<u>S. trifida</u>	-	II I I B ₅ O Y	III III III A ₃ A ₃ A ₁₁	-	-	-	-

TABLE - XIII A contd.

-253-

Taxa	Stem	Petiole	Leaf lamina		Leaf margin	Inflorescence axis
			Upper	Lower		
<u>Euphrasia officinalis</u>	II III R U	II II R U	III III R U	III R	III R	-
<u>E. laxa</u>	II III B ₁ F	-	III W	-	III III A ₁₁ W	-
<u>E. laeschkei</u>	III I III B ₇ J W	-	III T	-	III III A ₇ T	-
<u>Pedicularis pectinata</u> <u>ssp. bipinnatifida</u>	-	-	III A ₁	-	II A ₁	-
<u>P. pectinata</u> var <u>typica</u>	II III III E F C	II III III E F C	-	III III F C	-	-
<u>P. brevifolia</u>	III J	-	-	-	-	-
<u>P. flexuosa</u>	III II C J	-	II II C D	II III C D	II D	-
<u>P. verticillata</u>	II II II II D F J R	-	-	-	-	-
<u>P. bifida</u>	II C	-	II R	III II I C R W	III C	-
<u>P. asplenifolia</u>	I F	-	-	-	-	III F
<u>P. pyramidata</u>	II E	-	I III E T	I I A ₁ T	-	-
<u>P. plantaginifolia</u>	I C	-	II D	-	-	-
<u>P. oderi</u>	III J	-	III R	I III B ₅ R	-	-

I = Scarce; II = Frequent; III = Abundant

TABLE - XIII B contd.

Taxa	Pedice	Bract/ Bracteole	Calyx	Corolla	Stamens	Stigma/ style	Ovary
<u>Euphrasia officinalis</u>	III II II R U Y	-	III III II R U Y	I B ₃	-	-	-
<u>E. laxa</u>	-	-	III III A ₁₁ W	III III II A ₆ I W	-	III A ₇	III A ₇
<u>E. laeschkei</u>	-	-	III III A ₇ T	III I B ₇ T	-	III A ₇	III A ₇
<u>Pedicularis pectinata</u> <u>ssp. bipinnatifida</u>	-	III II J T	III II J T	III III R T	II II C J	-	-
<u>P. pectinata</u> var <u>typica</u>	-	-	III III III III F C R W	II II III III E F R W	II R	-	-
<u>P. brevifolia</u>	-	-	II C	III T	III C	-	-
<u>P. flexuosa</u>	-	-	III III C J	II III II III E C J R	-	-	-
<u>P. verticillata</u>	-	III II II A ₁ J R	III III III II II D J R T W	II II II III A ₁ E R T	-	-	-
<u>P. bifida</u>	-	-	II II II III C D F R	-	-	-	-
<u>P. asplenifolia</u>	III F	-	II II J F	II I III I O R	II I	-	-
<u>P. pyramidata</u>	-	-	III III J T	II II III C E T	III E	-	-
<u>P. plantilingii</u>	-	III II C D	III II II C D J	II III J T	-	-	-
<u>P. oderi</u>	-	I III I B ₅ J R	II II I J R W	III R	III C	-	-

I = Scarce; II = Frequent; III = Abundant.

TABLE - XIV A contd.

Trichome types	Code	TAXA NOS.																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Uniseriate filiform	C	+						+	+		+	+		+	+	+	+			+	+
Uniseriate conical	D	+						+	+	+	+	+		+							
Uniseriate cylindrical	E							+				+					+				
Uniseriate curved	F			+					+	+	+	+			+					+	
Uniseriate hooked	G							+									+				
Uniseriate acuminate	H																				
Uniseriate aseptate flagellate	I																				
Uniseriate septate flagellate	J			+				+			+			+	+			+	+		
Peltate glandular	O	+																			
Peltate porous glandular	Q		+																		
Unicellular glandular capitate	R			+		+		+	+	+	+	+	+	+	+		+	+		+	+
Bicellular glandular capitate	T											+				+					
Bicellular glandular capitate vesicular	U																				
Uniseriate glandular	V				+					+	+	+				+					
Uniseriate glandular capitate	W	+		+				+	+							+	+		+		
Uniseriate glandular capitate vesicular	X																				
Brevicollate glandular capitate	Y																				
Number of types of trichome per species		4	2	4	1	1	3	9	9	5	7	9	2	4	5	5	5	8	5	5	4

TABLE - XIV B contd.

Trichome types	Code	TAXA NOS.																			No. of species
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	
Uniseriate filiform	C				+						+	+	+	+		+	+	+	+	+	21
Uniseriate conical	D		+			+							+	+	+				+		13
Uniseriate cylindrical	E											+	+	+				+			7
Uniseriate curved	F								+			+			+	+	+				12
Uniseriate hooked	G																				2
Uniseriate acuminate	H	+																			1
Uniseriate aseptate flagellate	I								+												1
Uniseriate septate flagellate	J									+	+		+	+	+		+	+	+	+	17
Peltate glandular	O			+																	2
Peltate porous glandular	Q																				1
Unicellular glandular capitate	R				+	+		+			+	+		+	+	+	+			+	24
Bicellular glandular capitate	T	+					+			+	+		+		+			+	+		10
Bicellular glandular capitate vesicular	U							+													1
Uniseriate glandular	V																				5
Uniseriate glandular capitate	W								+	+		+			+	+				+	13
Uniseriate glandular capitate vesicular	X			+		+															2
Brevicollate glandular capitate	Y						+	+													2
Number of types of trichome per species		6	4	8	7	8	7	4	7	5	5	5	3	5	8	5	4	5	4	5	

CHAPTER V

GENERAL DISCUSSION

CHAPTER - V

GENERAL DISCUSSION

The family Scrophulariaceae is a fairly large family of the order Personales, duly recognized by all the systematists. Since this is a large family, it has been divided into sub-families or series and tribes. The terms Pseudosolanaceae, Antirrhinideae and Rhinanthideae were established by Bentham and Hooker (1837) as series, and by Wettstein (1897) as sub-families.

Hooker (1885) placed 9 tribes in the three series vis., Verbaceae and Aptosimeae in the series Pseudosolanaceae, Antirrhineae, Cheloneae, Mamuleae and Gratioloae in Antirrhinideae, and Digitaleae Gerardiae and Euphrasieae in Rhinanthideae. Some of the tribes were further divided into sub-tribes, such as Gratioloae into sub-tribes Mimuleae, Stenodieae, Herpestideae, Vandeliae and Limoselleae; Digitaleae into Sibthorpiae, Rudigitaleae and Veroniceae, and Gerardiae into Escobediae, Buchneareae and Eugerardiae.

The family Scrophulariaceae is not only important from the point of view of its wild taxa which show great

variation in morphological characters but also due to some interesting medicinal and ornamental plants. The most interesting and medicinally important plant of the family is Digitalis whose medicinal values have already been established by various workers (Withering, 1785; Hirotsu & Furuya, 1975 and Datta & Ghosh, 1985). Many plants of the Scrophulariaceae are valued as garden ornamentals, notable among them are snapdragons (Antirrhinum sp.), speedwells (Veronica sp.), slipper flower (Calceolaria sp.), beard tongues (Penstemon sp.), monkey flower (Mimulus sp.), henilworthy ivy (Cymbalaria sp.), coral plant (Ruellia sp.), wish-bone flower (Torenia sp.), turtle head (Chelone glabra), toad flax (Linaria sp.), woodbetony or house wort (Pedicularis sp.) and fox-glove (Digitalis sp.). The name Rhinanthaceae was also suggested for this family but Scrophulariaceae has been conserved.

Important morphological characters of the family are the occurrence of few chlorophyll-less parasite (Hyobanche) and others chlorophyll containing parasites (Melampyrum, Pedicularis, Castilleja), bisexual, typically syngamorphic flowers, stamens 4-didynamous, epipetalous, sometimes 5 stamens (Verbascum, Capararia), when the stamens are 4, the posterior one may be suppressed or abortive and represented by a staminode as in Penstemon or reduced to scale

as in Scrophularia, sometimes the stamens are only two g.g., Veronica, Calceolaria. Carpels are two, placed medianly, with axile placentation.

The Scrophulariaceae is separated from Solanaceae by sygomorphic corolla, collateral vascular bundles, and usually reduction of posterior stamen; from Gesneriaceae and Orobanchaceae by the bilocular ovary; from the Pedaliaceae and Bignoniaceae by the presence of endosperm.

Hooker (1885) recognized fifty six genera with Oreocolan and Falconeria as the genera of doubtful position in the family. In the present investigation 39 genera spread to 98 species, representing all the 9 tribes of the three series have been studied.

The family has so far been studied in mainly covering the aspects of morphology (Canne, 1983a; Karlsson, 1984; Lee & Stuckey, 1985 and Al-Musawi & Al-Barmani, 1986), embryology (Tiagi, 1956, 1965, 1966; Arkal, 1963; Kumar & Tiagi, 1981; Natesh & Bhanderi, 1984; Shah, 1985 and Elisens, 1986), anatomy (Metcalf & Chalk, 1950; Datta & Deb, 1975; Deb & Datta, 1977; Kristen & Juergen, 1985; and Michener, 1983, 1986) and Cytology (Canne, 1983b; Hong, 1984; Vitek, 1985, 1986 and Nirek & Fischer, 1986).

During the last century considerable interest seems to have been created in studying plant trichomes, and recently extensive work has been done on different aspects of trichomes in many families. However, in the family *Scrophulariaceae*, barring a few publications on trichome morphology and their classification, much work has not been done. A resume of previous work is included by Metcalfe & Chalk (1950), who themselves demonstrated the presence of nonglandular and glandular hairs on both vegetative and floral parts of some taxa of this family. Among the nonglandular forms, unicellular, uniseriate and branched (dendroid) types were recorded by them in *Leucophyllum*, *Paulownia* and *Verbascum*. The glandular hairs were distinguished on the basis of number of cells in stalk and head. Solereder (1908) recorded peltate glandular and peltate porous glandular hairs in the genera *Bartsia*, *Euphrasia*, *Herpestis*, *Melanopyrum*, *Pedicularis*, *Rhinanthes* and *Tossia*. Subsequently Datta & Deb (1975) studied trichomes of 24 species of the *Scrophulariaceae* and classified them into nonglandular and glandular ones.

Except the few references quoted above, the family has not been investigated by other workers for their trichomes. Since it is generally regarded as one of the

highly advanced groups of Angiosperms, its trichomes are expected to possess great variety of forms. The work done in this field is not extensive as compared to the large size of the family. Keeping in view this fact, the present endeavour seems probably the first exhaustive work on trichome morphology of the family Scrophulariaceae.

From the present studies of 98 species belonging to 39 genera of the family, a total number of 46 types of hairs were recorded. All these forms of hairs have been grouped into two main categories i.e., nonglandular and glandular. Each category of hairs was further divided into sub-categories on the basis of number of rows and number of cells in each row, the former in three sub-categories and latter in five (Table XVIII).

The nonglandular trichomes as shown in Table XVI are divided into unicelled, bicelled and multicelled types, depending upon the number of cells forming the body of trichome. The multicellular types are further distinguished into uniseriate, stellate and dendroid forms. Unicellular trichomes are classified into 11 categories (viz., papillose, clavate, flagellate, filiform, acerate, acuminate, conical, hooked, cylindrical, curved and dentate) on the basis of the final form of the trichome. These are found distributed to all the three series. A particular series

can be distinguished on the basis of absence of few such hairs, for example, Pseudosolanaceae does not show unicellular acerate, unicellular hooked and unicellular curved forms, Antirrhinideae in the absence of unicellular filiform types and Rhinanthideae in not having unicellular cylindrical ones.

Bicellular hairs are not so common as unicellular types. Out of 8 types under this category, Pseudosolanaceae shows the presence of only 2 types (bicellular conical & bicellular aseptate flagellate forms). Antirrhinideae and Rhinanthideae show the presence of 7 types. The hairs common to them are bicellular filiform, conical, cylindrical, curved, acuminate and aseptate flagellate, the former series is characterized by the presence of bicellular hooked and latter by bicellular furcate forms.

Nine types of uniseriate hairs were recorded in the entire family out of which Rhinanthideae is having 8 and Antirrhinideae 7 forms. These two series are related on the basis of uniseriate hairs. They are uniseriate filiform, conical, cylindrical, hooked, acuminate, aseptate flagellate and septate flagellate. But these can be separated by the specific type which they have, Rhinanthideae by uniseriate curved and Antirrhinideae by uniseriate furcate type. The Pseudosolanaceae shows only two forms of uniseriate hairs i.e., uniseriate filiform and conical ones.

Dendroid and various other forms of stellate hairs were recorded only in the series Pseudosolanaceae, which is thus markedly separated from the other two series.

All the 11 forms of glandular trichomes are classified into peltate, unicellular, bicellular, uniseriate and brevicoliate types.

Three forms of peltate trichomes i.e., peltate glandular, peltate glandular vesicular and peltate porous glandular are observed, all the three forms have been recorded in the series Antirrhinideae. Rhinanthideae is characterized by the absence of peltate glandular vesicular and Pseudosolanaceae shows only peltate porous glandular types.

Out of the two types of unicellular glandular hairs, unicellular glandular capitate is the most common, represented by 51 taxa belonging to the three series. Antirrhinideae and Rhinanthideae each show in 24 taxa and 3 taxa of Pseudosolanaceae, while the unicellular glandular capitate vesicular type is shown by only Limnophila chinensis of Antirrhinideae.

Like unicelled glandular, bicellular glandular trichomes are also of two types i.e., bicellular glandular capitate and bicellular glandular capitate vesicular.

The former type is shown by all the three series, while the latter by two series i.e., Antirrhinideae and Rhinanthideae (Table XVII). Maximum number of species (21) showing bicellular glandular capitate hairs belong to Antirrhinideae, followed by 10 species of Rhinanthideae and 4 of Pseudosolaneae; the latter form of the hair being restricted to Antirrhinideae and Euphrasia officinalis of Rhinanthideae.

Amongst multicellular glandular hairs only 3 forms i.e., uniseriate glandular, uniseriate glandular capitate and uniseriate glandular capitate vesicular were recorded. Uniseriate glandular capitate hairs were observed in the taxa of all the series. These trichomes were found to be distributed in the maximum number of species of the series Antirrhinideae (i.e., 26) followed by Rhinanthideae (12) and Pseudosolaneae (3). The series Pseudosolaneae may be distinguished from the remaining series in the absence of uniseriate glandular and uniseriate glandular capitate vesicular hairs.

Brevicollate glandular capitate hairs seem to be distinct not only in their unique structure (a differentiated hair having a short stalk, with two broad globular cells, Plate 10, Fig. 43), but are restricted also in their distribution under this family. Though all the series of

this family are represented by this form of hairs, however, their distribution and frequency is restricted and it is represented only in 7 taxa out of 98 species studied (1 taxon under Pseudosolanaceae, 2 taxa under Rhinanthideae and 4 in the series Antirrhinideae). The Tables V, IX & XIII clearly indicate the variation in frequency of their distribution, i.e., in series Pseudosolanaceae and Rhinanthideae they are frequent and scarce, while in Antirrhinideae they are abundant on upper leaf surface of Scrophularia calycina and S. urticifolia and on bract/bracteole of S. decomposita ssp. latifolia, whereas in other parts of the aforesaid taxa, they are scarcely found.

The distribution of the total trichomes observed in the three different series of Scrophulariaceae is shown below:

Trichome category	Pseudosolanaceae	Antirrhinideae	Rhinanthideae
Nonglandular	19 types	25 types	25 types
Glandular	5 types	11 types	9 types

The above trichome analysis clearly reveals that nonglandular type of hairs are of more common occurrence than the glandular ones.

In the nonglandular forms, unicellular hairs are the most common types and a total number of 11 types were recorded on almost all the parts of the studied taxa; the reproductive parts showed the absence of some forms like unicellular hooked and unicellular curved forms. Each of the series showed maximum representation of these hairs. Antirrhinideae and Rhinanthideae showed 10 such forms each, but the former is lacking in unicellular filiform, and the latter in not having unicellular cylindrical ones. The series Pseudosolanaceae is distinguished by the absence of unicellular acerate, unicellular hooked and unicellular curved forms. From these hairs, unicellular papillose is represented by maximum number of taxa i.e., 25 species and observed on all the parts, except on inflorescence axis, followed by unicellular flagellate and unicellular conical types in 22 species each. Some of the unicellular hairs are rather restricted in distribution and were recorded in 2 to 3 species, such as unicellular filiform in Verbascum soongraecum (Pseudosolanaceae) Veronica agrestis (Rhinanthideae) and unicellular acerate in Lindenbergia grandiflora, L. muraria (Antirrhinideae) and Sopubia trifida (Rhinanthideae). Some of the unicellular forms were recorded only on the floral parts. The unicellular clavate type were observed in 20 taxa, on corolla and stamens, unicellular acerate in 3 taxa on all the floral parts except inflorescence axis and

ovary. The remaining types were recorded on both vegetative and floral parts.

From bicellular category of hairs, 8 forms were recorded in the family. Antirrhinideae and Rhinanthideae showed the presence of 7 types each, and Pseudosolanaceae showed only 2 types, which are also shared by the first two above mentioned series.

The series Antirrhinideae and Rhinanthideae may be distinguished by the presence of specific forms of hairs, the former by bicellular furcate type recorded only in Russelia coccinea and the latter by bicellular hooked type in Striga euphrasioides, Centranthes nepalensis, Sorubia trifida and Pedicularis oederi. These type of hairs were recorded on both vegetative and floral organs of the taxa of these series. But some are restricted in distribution and observed only on vegetative parts, for example, bicellular acuminate in Lindenbergia grandiflora, Vandellia mollis and Russelia coccinea of Antirrhinideae and in Alectra parasitica var. chitrakutensis of Rhinanthideae.

Under the category of uniseriate trichomes, there are 9 forms. Amongst these, uniseriate filiform and uniseriate conical ones are of most common in distribution, recorded in all the 3 series. Other forms of

uniseriate hairs are distributed in the Antirrhinideae and Rhinanthideae. In the series Pseudosolanaceae, uniseriate filiform and uniseriate conical types of hairs were observed in Celsia coromandelina and Anticharis glandulosa, in Antirrhinideae. Similar forms of hairs were recorded in 13 & 11 species and in Rhinanthideae in 21 and 13 species respectively.

In some uniseriate hairs, the body is differentiated into a flagellated structure. Flagellated hairs are classified into aseptate and septate types on the basis of absence or presence of septum. Aseptate flagellate forms were recorded in Euphrasia laxa of Rhinanthideae and Lindenbergia muraria and Torenia violacea of Antirrhinideae. Septate flagellate form is of more common occurrence and was observed in 24 taxa of these two series (i.e. 7 of Antirrhinideae and 17 of Rhinanthideae).

Other forms of uniseriate hairs which are common to Antirrhinideae and Rhinanthideae are cylindrical, hooked and acuminate types. These two series can be separated from one another on the basis of specific form of hairs which they have i.e., uniseriate furcate in Antirrhinideae and uniseriate curved in Rhinanthideae. Uniseriate acuminate type is rare in its distribution observed in only 3 taxa, namely Striga orobanchoides (Rhinanthideae) and

Lindenbergia grandiflora and Vandellia mollis (Antirrhinaceae), out of 98 species studied. Uniseriate hairs are more common on the vegetative parts as compared to the floral organs.

Stellate hairs are classified into sessile and stalked forms. These are further divided into various categories on the basis of number of cells forming rays viz., bi, tri, tetra and multiradiate types. These hairs were recorded in the species of Verbascum of the tribe verbasceae, included in the series Pseudosolanaceae. Sessile stellate multiradiate and stalked stellate multiradiate ones were observed in all the 4 species of Verbascum studied. Sessile stellate triradiate in V. erianthum, stalked stellate biradiate and triradiate in V. soongora, and stalked stellate tetrameradiate in V. thapsus. These hairs were found distributed on both vegetative and floral parts including the ovary.

The last category of multicellular hairs is the dendroid form, recorded in Verbascum thapsus and V. erianthum of Pseudosolanaceae on both vegetative and floral organs.

All the 11 forms of glandular hairs were recorded in the series Antirrhinaceae. The most common type of hair observed on all the parts of the taxa studied was

uniseriate glandular capitate. These trichomes also showed heterogeneity in their organographic distribution. Most of them were recorded on both vegetative and floral organs. Some were restricted in their distribution, such as bicellular glandular capitate vesicular, and uniseriate glandular ones found only on the floral parts, the former in Scrophularia decomposita var. typica, Limnophila chinensis and Ruellia equisetiformis and the latter in Scrophularia urticifolia, Vandellia mollis, Angelonia gardenieri and Calceolaria gracilis. The only form of glandular hair recorded on the vegetative part, i.e., stem of Limnophila chinensis is unicellular glandular capitate vesicular. Uniseriate glandular capitate vesicular, unlike uniseriate glandular capitate was recorded only in 3 species on both the organs viz., Antirrhinum orontium, A. majus and Angelonia grandiflora.

Rhinanthideae showed the presence of 9 types of glandular hairs, amongst which unicellular, glandular capitate was the most common one recorded in 24 taxa. Uniseriate glandular capitate vesicular, and brevicolate glandular capitate were observed on the floral parts of Striga euphrasioides and Sorubia delphinifolia and Sorubia trifida and Euphrasia officinalis respectively. Remaining forms of hairs were recorded on both vegetative and floral parts. The trichome types of rare occurrence in series

Rhinanthideae were peltate porous glandular, in Scoparia dulcis and bicellular glandular capitate vesicular in Euphrasia officinalis.

The series Pseudosolanaceae showed the presence of only 5 types of glandular hairs viz., peltate porous glandular, unicellular glandular capitate, bicellular glandular capitate, uniseriate glandular capitate and brevicoliate glandular capitate. The most common form of glandular hairs in this series is bicellular glandular capitate type recorded on both vegetative and floral parts of Verbascum thapsus, V. adenosopium, V. songraceum and Celsia coromandeliana. Peltate porous glandular hairs were observed on the vegetative parts of V. erianthum and V. songraceum.

Although trichomes vary in their structure within the large and smaller groups of plants, their structure and distribution in plants has great taxonomic significance which has long been recognized by a number of workers (Solerauer, 1908; Cowan, 1950; Metcalfe & Chalk, 1950; Goodspeed, 1954; Inandar, 1967; Ramayya, 1972; Bendre, 1973; Sahu, 1983 a, b & Mishra, 1984). According to Carlquist (1961), because of their accessibility the trichomes are perhaps the most important anatomical feature which could be used for taxonomic purposes. The study of trichomes of Rhododendron by

Cowan (1950) and Nicotiana by Goodspeed (1954) showed that they provide excellent characters for making delimitations at subgeneric and generic levels.

Ahmad (1978) has stressed that glandular hairs are more important at higher level (sub-family, tribe etc.) and nonglandular hairs are of diagnostic value at lower levels, such as genus, species and variety.

Plant hairs, which are so common on nearly all the plant organs are of great interest to descriptive and experimental botanists. Comparative data of trichomes may be important for studies on evolution and phylogeny. Carlquist (1961) has emphasised the role of trichomes in various aspects of physiological and ecological adaptations.

Forty six trichome types of the 98 species belonging to 3 series of the family Scrophulariaceae studied from their organographic distribution, are not only of morphological value, but also of taxonomic value and are useful in distinguishing the species and sometimes even their corresponding organs, which would be of interest to pharmacologists, palaeobotanists and agronomists.

TABLE - XVI : TOTAL TRICHOME TYPES OBSERVED IN THE FAMILY SCROPHULARIACEAE

S.No.	Trichome types	Code
<u>Nonangular</u>		
1.	Unicellular papillose	A ₁
2.	Unicellular clavate	A ₂
3.	Unicellular flagellate	A ₃
4.	Unicellular filiform	A ₄
5.	Unicellular acerate	A ₅
6.	Unicellular acuminate	A ₆
7.	Unicellular conical	A ₇
8.	Unicellular hooked	A ₈
9.	Unicellular cylindrical	A ₉
10.	Unicellular curved	A ₁₀
11.	Unicellular dentate	A ₁₁
12.	Bicellular filiform	B ₁
13.	Bicellular conical	B ₂
14.	Bicellular cylindrical	B ₃
15.	Bicellular curved	B ₄
16.	Bicellular hooked	B ₅
17.	Bicellular acuminate	B ₆
18.	Bicellular aseptate flagellate	B ₇
19.	Bicellular furcate	B ₈
20.	Uniseriate filiform	C
21.	Uniseriate conical	D

Table - XVI contd.

S.No.	Trichome types	Code
22.	Uniseriate cylindrical	E
23.	Uniseriate curved	F
24.	Uniseriate hooked	G
25.	Uniseriate acuminate	H
26.	Uniseriate aseptate flagellate	I
27.	Uniseriate septate flagellate	J
28.	Uniseriate furcate	K
29.	Sessile stellate triradiate	L ₁
30.	Sessile stellate multiradiate	L ₂
31.	Stalked stellate biradiate	M ₁
32.	Stalked stellate triradiate	M ₂
33.	Stalked stellate tetraradiate	M ₃
34.	Stalked stellate multiradiate	M ₄
35.	Dendroid	N
<u>Glandular</u>		
36.	Peltate glandular	O
37.	Peltate glandular vesicular	P
38.	Peltate porous glandular	Q
39.	Unicellular glandular capitate	R
40.	Unicellular glandular capitate vesicular	S
41.	Bicellular glandular capitate	T
42.	Bicellular glandular capitate vesicular	U
43.	Uniseriate glandular	V
44.	Uniseriate glandular capitate	W
45.	Uniseriate glandular capitate vesicular	X
46.	Brevicollate glandular capitate	Y

TABLE - XVII : DISTRIBUTION OF TRICHOME TYPES AMONG THE THREE SERIES OF THE FAMILY SCROPHULARIACEAE

S. No.	Trichome Type	Code	Pseudo-solanaceae	Antirrhinaceae	Rhinanthaceae
	<u>Nonlandular</u>				
1.	Unicellular papillose	A ₁	+	+	+
2.	Unicellular clavate	A ₂	+	+	+
3.	Unicellular flagellate	A ₃	+	+	+
4.	Unicellular filiform	A ₄	+		+
5.	Unicellular acerate	A ₅		+	+
6.	Unicellular acuminate	A ₆	+	+	+
7.	Unicellular conical	A ₇	+	+	+
8.	Unicellular hooked	A ₈		+	+
9.	Unicellular cylindrical	A ₉	+	+	
10.	Unicellular curved	A ₁₀		+	+
11.	Unicellular dentate	A ₁₁	+	+	+
12.	Bicellular filiform	B ₁		+	+
13.	Bicellular conical	B ₂	+	+	+
14.	Bicellular cylindrical	B ₃		+	+
15.	Bicellular curved	B ₄		+	+

Table - XVII contd.

S. No.	Trichome type	Code	Pseudo-solanaceae	Antirrhinaceae	Rhinanthaceae
16.	Bicellular hooked	B ₅			+
17.	Bicellular acuminate	B ₆		+	+
18.	Bicellular aseptate flagellate	B ₇	+	+	+
19.	Bicellular furcate	B ₈		+	
20.	Uniseriate filiform	C	+	+	+
21.	Uniseriate conical	D	+	+	+
22.	Uniseriate cylindrical	E		+	+
23.	Uniseriate curved	F			+
24.	Uniseriate hooked	G		+	+
25.	Uniseriate acuminate	H		+	+
26.	Uniseriate aseptate flagellate	I		+	+
27.	Uniseriate septate flagellate	J		+	+
28.	Uniseriate furcate	K		+	
29.	Sessile stellate triradiate	L ₁	+		
30.	Sessile stellate multiradiate	L ₂	+		
31.	Stalked stellate biradiate	M ₁	+		

Table - XVII contd.

S. No.	Trichome type	Code	Pseudo-solanese	Antirrhinideae	Rhinanthideae
32.	Stalked stellate triradiate	M ₂	+		
33.	Stalked stellate tetraradiate	M ₃	+		
34.	Stalked stellate multiradiate	M ₄	+		
35.	Dendroid	N	+		
	<u>Glandular</u>				
36.	Peltate glandular	O	+	+	+
37.	Peltate glandular vesicular	P		+	
38.	Peltate porous glandular	Q		+	+
39.	Unicellular glandular capitate	R	+	+	+
40.	Unicellular glandular capitate vesicular	S		+	
41.	Bicellular glandular capitate	T	+	+	+
42.	Bicellular glandular capitate vesicular	U		+	+
43.	Uniseriate glandular	V		+	+
44.	Uniseriate glandular capitate	W	+	+	+
45.	Uniseriate glandular capitate vesicular	X		+	+
46.	Brevicollate glandular capitate	Y	+	+	+
Number of trichome types per series			24	36	34

+ = Presence

CHAPTER VI

SUMMARY AND CONCLUSIONS

CHAPTER - VI

SUMMARY AND CONCLUSIONS

The present study is based on 98 species belonging to 39 genera representing 3 series viz., Pseudosolanaceae, Antirrhinideae and Rhinanthideae of the family Scrophulariaceae.

The Scrophulariaceae is a large family comprising about 220 genera and 3,000 species, represented very well in temperate regions of both the hemispheres. Among the Indian flora though they are common in plains yet occur in large numbers on the mountains too.

The family Scrophulariaceae is not only important from the point of view of wild taxa which show great variation in morphological characters, but also due to some interesting medicinal and ornamental plants. The most interesting and medicinally important plant of this family is Digitalis (fox glove). The plants of Scrophulariaceae are valued primarily as garden ornamentals.

Much has been written about Scrophulariaceae pertaining to its various aspects like foliar anatomy,

floral anatomy, wood anatomy, cytology, embryology, morphology and taxonomy; work done on the trichomes of this family is not extensive as compared to its large size. Information so far available on the trichomes of Scrophulariaceae are too meagre and no extensive work seems to have been done in this respect.

In view of the facts mentioned above, the present investigation was undertaken. It deals with a detailed study of structure, organographic distribution and taxonomic significance of vegetative as well as floral trichomes to assess their usefulness in solving taxonomic problems within the family.

From the present study, a total number of 46 types of trichomes were recorded. All these forms of hairs have been grouped into two main categories i.e., nonglandular (35 types) and the glandular (11 types).

The nonglandular trichomes are divided into unicelled (11 types), bicelled (8 types) and multiseriate (depending upon the number of cells forming the body of trichome). The last category of hairs (i.e., multiseriate) are further distinguished into uniseriate (9 types), stellate (6 types) and dendroid forms.

The glandular trichomes are classified into peltate (3 types), unicellular (2 types), bicellular (2 types), uniseriate (3 types) and brevicolate glandular capitate.

Distribution of total trichomes observed in the three different series of the family is shown below:

Trichome category	Pseudo-solanaceae	Antirrhinideae	Rhinanthideae
Nonglandular	19 types	25 types	25 types
Glandular	5 types	11 types	9 types
Total number of types per series	24 types	36 types	34 types

The above trichome analysis clearly reveals that nonglandular hairs are of more common occurrence than the glandular ones. The use of trichomes in taxonomy is well established and their significance has been emphasized by many workers. Some families can be easily distinguished on the basis of particular type of hairs. In other cases, they are important in the taxonomic delimitation of genera and species. In the present work also it is observed that trichomes can be used as taxonomic markers of different series and taxa of Scrophulariaceae.

The following points reveal taxonomic significance of trichomes as observed in the present investigation:

1) The series *Pseudosolanaceae*, *Antirrhinideae* and *Rhinanthideae* exhibit similarity in some trichome types whereas in other types they show heterogeneity. These three series resemble one another in the presence of unicellular (papillose, flagellate, acuminate, conical, cylindrical and dentate), bicellular (conical & aseptate flagellate), uniseriate (filiform & conical), peltate porous glandular, unicellular glandular capitate, bicellular glandular capitate, uniseriate glandular and brevicollate glandular capitate hairs. However, these can be separated apart on the basis of specific forms of hairs which are restricted to them. *Pseudosolanaceae* is characterized by the presence of various forms of stellate and dendroid hairs, recorded only in this series.

The series *Antirrhinideae* and *Rhinanthideae* may also be distinguished from each other and from *Pseudosolanaceae* by the presence of specific forms of hairs, the former by bicellular furcate, uniseriate furcate, peltate glandular vesicular and unicellular glandular capitate vesicular types and the latter by bicellular hooked and uniseriate curved forms.

2) In the nonglandular category, unicellular hairs are most common (11 types) and were recorded on all the parts of the studied taxa, except the reproductive parts

which showed the absence of some forms like unicellular hooked and unicellular curved. Unicellular papillose is represented by maximum number of taxa i.e., 25 species, followed by unicellular flagellate and unicellular conical types in 22 species each. Some of the unicellular forms are rather restricted in distribution and were recorded in 2 to 3 species such as unicellular filiform Verbascum soongraecum (Pseudosolanaceae) and Veronica agrestis (Rhinanthideae), unicellular acerate in Lindenbergia grandiflora and Lindenbergia muraria (Antirrhinideae) and Sorubia trifida (Rhinanthideae).

3) Eight types of bicellular hairs were recorded in the family. Pseudosolanaceae showed only two types, while Antirrhinideae and Rhinanthideae each showed seven types. The series Antirrhinideae is marked by the presence of bicellular furcate and Rhinanthideae by bicellular hooked hairs.

4) Under the category of uniseriate trichomes, 9 forms were observed. Amongst these, uniseriate conical and uniseriate filiform ones were most common in distribution, recorded in all the three series. Uniseriate acuminate type was rare in its distribution observed in only three species mainly Striga orobanchoides (Rhinanthideae) and Lindenbergia grandiflora and Vandellia mollis (Antirrhinideae).

Uniseriate conical forms have been observed in 35 species of the family, 21 in Antirrhinideae, 13 in Rhinanthideae and the only species of Pseudosolanaceae is Anticharis glandulosa in which uniseriate conical hairs were observed.

5) Various forms of stellate (6 types) and dendroid hairs were recorded only in the species of Verbascum of the tribe verbasceae included in the series Pseudosolanaceae. These forms of hairs were found distributed on both vegetative and floral parts including ovary.

6) A total number of 11 types of glandular hairs have been observed, all were recorded in Antirrhinideae, while 9 types in Rhinanthideae and 5 types in Pseudosolanaceae. The most common type of glandular hair is unicellular glandular capitate, observed in 51 taxa of the family. Antirrhinideae and Rhinanthideae topped the list with 24 species in each and 3 of Pseudosolanaceae. In the series Pseudosolanaceae, the common type of hairs of this category is bicellular glandular capitate recorded in 4 species out of 7 while, Rhinanthideae and Antirrhinideae show it in 2 and 10 species respectively. The glandular hairs are of rare occurrence and were recorded only in a few taxa of the series Antirrhinideae which are peltate glandular vesicular, bicellular, glandular capitate vesicular and uniseriate

glandular capitate vesicular each in 3 taxa and unicellular glandular capitate vesicular (Limnophila chinensis).

7) Brevicollate glandular capitate hairs seem to be distinct not only in their unique structure but are restricted also in their distribution under this family. Though these hairs are observed in all the three series, however, their distribution and frequency is restricted and were recorded only in 7 species (1 taxon under Pseudosolanaceae, 2 taxa in Rhinanthideae and 4 in the series Antirrhinideae).

8) A number of species are characterized by their typical types of trichomes. For example, in series Pseudosolanaceae, Anticharis glandulosa possesses unicellular flagellate, unicellular cylindrical, bicellular conical, uniseriate conical hairs, Verbascum thapsus - stalked stellate tetroradiate; Verbascum erianthum - sessile stellate triradiate; Verbascum adenoseplum - unicellular acuminate; Verbascum soongraecum - unicellular filiform, stalked stellate biradiate, stalked stellate triradiate and brevicolate glandular capitate, and Celsia coromandeliana unicellular dentate bicellular asperate flagellate and uniseriate filiform ones.

9) Lindenbergia indica, Russelia coccinea and Limnophila gratioloides are distinctive from Antirrhinideae

in possessing specific forms of trichomes recorded only in them e.g., bicellular aseptate flagellate, bicellular furcate and unicellular glandular capitate vesicular forms respectively.

10) The taxa of the series Rhinanthideae showed specific types of hairs which became their taxonomic markers, such as unicellular clavate - digitalis purpurea, unicellular filiform - Veronica agrestis, unicellular acerate - Sorbus trifida, unicellular curved - Veronica biloba, bicellular acuminate - Alectra parasitica var. chitrakutensis, uniseriate acuminate - Striga orobanchoides, uniseriate aseptate flagellate - Euphrasia laxa, peltate porous glandular - Scooparia dulcis and bicellular glandular capitate vesicular - Euphrasia officinalis.

11) Veronica and Pedicularis are represented by maximum number of species studied, former including 11 and the latter 10 species. Some of the species of these genera are taxonomically quite distinct on the basis of presence of typical type of trichome different from other species.

Veronica anacalis-aquatica and V. beccabunga showed uniseriate glandular and unicellular glandular capitate hairs respectively, whereas V. agrestis is characterized by the total absence of glandular hairs, thus showing their isolated position in Veronica complex.

Species of Pedicularis are characterized by very rare occurrence of unicellular and bicellular hairs. Only two types of such hairs were recorded, e.g., unicellular papillose in Pedicularis pectinata ssp. latifolia, P. verticillata and P. pyramidata and bicellular hooked in P. oderi. Uniseriate filiform is the most common type of hair recorded in all the species of Pedicularis except P. verticillata.

12) The organographic distribution of trichome types observed in the family Scrophulariaceae also shows heterogeneity, unicellular clavate and unicellular acerate recorded on floral parts only, bicellular acuminate, bicellular furcate and unicellular glandular capitate vesicular on vegetative organs and the remaining types on both the organs.

SOME IMPORTANT RESULTS OBTAINED FROM TRICHOME STUDIES

The following are some of the important findings based on the observations of trichome studies of the family Scrophulariaceae on the basis of which conclusions may be drawn.

- 1) Maximum number of types of trichomes have been recorded in the taxa of the family Scrophulariaceae as compared to other families.
- 2) The terms, peltate porous glandular and brevicollate glandular capitate have been used for the first time in this family.
- 3) In contrast to the observations of other authors, maximum number of nonglandular form of hairs (35 types) were recorded than the glandular forms (11 types).
- 4) The three series of the family can be separated from one another on the basis of their specific trichome compliments, e.g.,

Pseudosolanaceae : Stellate and dendroid forms of the hairs.

Antirrhinideae : Bicellular and uniseriate furcate, peltate glandular vesicular, and unicellular glandular capitate vesicular forms.

Rhinanthideae : Bicellular hooked, and uniseriate curved forms.

I. Series - Pseudosolanese

- 1) Anticharis linearis differs from A. glandulosa in the absence of unicellular flagellate, bicellular conical and uniseriate conical type of trichomes.
- 2) Stellate and dendroid forms of the hairs are restricted only to the genus Verbascum, all the four species of which resemble each other in the presence of stalked stellate multiradiate trichomes.
- 3) Celsia is quite different from Verbascum, due to the absence of stellate and dendroid forms of hairs.

II. Series - Antirrhinideae

- 1) Lindenbergia indica and Russelia coccinea are specific in having bicellular aseptate flagellate and bicellular furcate hairs which are not observed in any other taxon of this series.
- 2) Masus japonicus, M. surculosus, M. dentatus and M. pumilus have been found similar to each other in having uniseriate conical hairs.

- 3) Lindenbergia grandiflora, L. macrostachya, L. indica, and L. muraria, resemble each other in having uniseriate filiform and uniseriate glandular capitate form of hairs, but have heterogeneity in other forms.
- 4) Linnophila species differ much from each other on the basis of types of trichome e.g., L. sessiliflora - unicellular clavate, L. gratioloidea - uniseriate conical and bicellular glandular capitate, L. chinensis - unicellular glandular capitate vesicular (recorded only in this species of series) and bicellular glandular capitate vesicular, and L. indica - bicellular filiform and uniseriate hooked.
- 5) Bacopa monnieri and B. procumbens differ from each other, former shows uniseriate cylindrical, uniseriate septate flagellate and peltate glandular hairs whereas the latter shows the presence of unicellular clavate and peltate porous glandular forms.
- 6) Craterostigma plantigena and C. pumilum also differ from one another by the absence of any type of glandular hairs in the former and the presence of unicellular glandular capitate and uniseriate glandular capitate ones in the latter.

- 7) Torenia cordifolia, T. fournieri and T. floribunda are similar to Lindernia crustacea, L. ciliata and L. parviflora in having unicellular dentate form of the hairs, but the latter group of taxa differ from the former group by the presence of bicellular glandular capitate forms.

III. Series - Rhinanthideae

- 1) Veronica anagalis-aquatica and V. baccabunga are very distinctive in possessing only one form of the trichome, uniseriate glandular in the former and unicellular glandular capitate in the latter.
- 2) Veronica agrestis differs from remaining 9 species in not having unicellular glandular capitate hairs.
- 3) The trichomes unicellular clavate, unicellular filiform, unicellular acerate, unicellular curved, bicellular acuminate, uniseriate acuminate, uniseriate aseptate flagellate, peltate porous glandular and bicellular glandular capitate vesicular, are extremely rare in distribution in this series. Each one of these forms is recorded only in one species e.g., Digitalis purpurea, Veronica agrestis, Scorubia trifida, Veronica biloba, Alectra parasitica, var. chitrakutensis, Strica orobanchoides, Euphrasia laxa, Scoraria dulcis and Euphrasia officinalis respectively.

- 4) Pedicularis pectinata var. typica, P. brevifolia,
P. flammosa, P. bifida, P. asplenifolia and
P. plantilingii differ from P. pectinata ssp.
hispidifida, P. verticillata, P. pyramidata in the
total absence of unicellular and bicellular glandular
hairs. P. verticillata is distinguished from 9
remaining species in not having uniseriate filiform
hairs, whereas P. pectinata var. typica and P. bifida
differ from other species in the absence of uniseriate
septate flagellate hairs.

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* Original not seen.

APPENDICES

APPENDIX - I : TRICHOME KEY TO THE TAXA OF SERIES PSEUDOSOLANAEAE

- 1 Uniseriate filiform present Celaia coronandelliana
- 1 Uniseriate filiform absent
- 2 sessile stellate multiradiate present
- 3 stalked stellate biradiate present Verbascum spongiosum
- 3 stalked stellate biradiate absent
- 4 Uniseriate acuminate present Verbascum adenosoplum
- 4 Uniseriate acuminate absent
- 5 Dendroid present
- 6 peltate glandular present Verbascum erianthum
- 6 peltate glandular absent Verbascum thapsus
- 5 Dendroid absent
- 2 sessile stellate multiradiate absent
- 7 Uniseriate conical present Anticharis glandulosa
- 8 Unicellular dentate present Anticharis linearis

APPENDIX - II : TRICHOME KEY TO THE TAXA OF SERIES ANTIARRHINIDEAE

- 1 Uniseriate glandular capitate present
 - 2 Uniseriate furcate present
 - 3 Uniseriate filiform present
 - 4 Unicellular glandular capitate present Lindenbergia indica
 - 4 Unicellular glandular capitate absent Lindenbergia muraria
 - 3 Uniseriate filiform absent Russelia coccinea
 - 2 Uniseriate furcate absent
 - 5 Uniseriate conical present
 - 6 Bicellular curved present Adenocma capitatum
 - 6 Bicellular curved absent
 - 7 Unicellular glandular capitate present
 - 8 Uniseriate filiform present Morus dentatus
 - 8 Uniseriate filiform absent
 - 9 Unicellular papillose present Morus pumilus
 - 9 Unicellular papillose absent Morus mucronatus
 - 7 Unicellular glandular capitate absent Mimus nepalensis
 - 5 Uniseriate conical absent
 - 10 Uniseriate cylindrical present Linaria renoussiana
 - 10 Uniseriate cylindrical absent
 - 11 Bicellular glandular capitate present
 - 12 Brevicollate glandular capitate present
 - 13 Uniseriate glandular present Scrophularia urticifolia
 - 13 Uniseriate glandular absent
 - 14 Unicellular glandular capitate on stamens Scrophularia calycina
 - 14 Uniseriate glandular capitate on stamens Scrophularia polyantha
 - 12 Brevicollate glandular capitate absent
 - 15 Unicellular glandular capitate present
 - 16 Peltate glandular present Stemodia viscosa
 - 16 Peltate glandular absent

Appendix - II contd.

- 17 Uniseriate septate flagellate present Stemodia sufruticosa
- 17 Uniseriate septate flagellate absent
 - 18 Peltate porous glandular present Angelonia grandiflora
 - 18 Peltate porous glandular absent Collinsia bicolor
- 15 Unicellular glandular capitate absent
 - 19 Unicellular dentate present Artemesia angustifolium
 - 20 Unicellular curved present Kickxia subsessilis
 - 21 Unicellular forms absent Angelonia gardneri
- 11 Bicellular glandular capitate absent
 - 22 Bicellular cylindrical present
 - 23 Peltate glandular present Lindenbergia sacrostachya
 - 23 Peltate glandular absent Lindenbergia grandiflora
 - 22 Bicellular cylindrical absent
 - 24 Uniseriate filiform present
 - 25 Uniseriate glandular present Calceolaria gracilis
 - 25 Uniseriate glandular absent Calceolaria mexicana
 - 24 Uniseriate filiform absent
 - 26 Unicellular hooked present Craterostigma punctatum
 - 26 Unicellular hooked absent Linaria vulgaris
 - 27 Only uniseriate glandular capitate & unicellular glandular capitate present Scrophularia decomposita var. typica
- 1 Uniseriate glandular capitate absent
 - 28 Uniseriate glandular capitate vesicular present
 - 29 Uniseriate cylindrical present Antirrhinum majus
 - 29 Uniseriate cylindrical absent Antirrhinum orontium
 - 28 Uniseriate glandular capitate vesicular absent
 - 30 Peltate porous glandular present
 - 31 Unicellular glandular capitate vesicular present Limnophila chinensis
 - 31 Unicellular glandular capitate vesicular absent

Appendix - II contd.

| | | |
|----|---|--------------------------------|
| 32 | Uniseriate flagellate present | <u>Limnophila gratioloides</u> |
| 32 | Uniseriate septate flagellate absent | |
| 33 | Unicellular dentate present | <u>Torenia fourieri</u> |
| 34 | Bicellular glandular capitate vesicular present | <u>Russelia equisetiformis</u> |
| 34 | Bicellular glandular capitate vesicular absent | |
| 35 | Bicellular curved present | <u>Russelia floribunda</u> |
| 35 | Bicellular curved absent | |
| 36 | Unicellular flagellate present | <u>Mimulus luteus</u> |
| 36 | Unicellular flagellate absent | |
| 37 | Unicellular clavate present | |
| 38 | Unicellular glandular capitate present | <u>Gratiola officinalis</u> |
| 38 | Unicellular glandular capitate absent | <u>Bacopa pruriens</u> |
| 37 | Unicellular clavate absent | <u>Dorstenia juncea</u> |
| 30 | Feltate porous glandular absent | |
| 39 | Feltate glandular present | |
| 40 | Bicellular glandular capitate present | |
| 41 | Unicellular glandular capitate present | <u>Lindernia crustacea</u> |
| 41 | Unicellular glandular capitate absent | <u>Lindernia ciliata</u> |
| 33 | Unicellular dentate absent | |
| 42 | Uniseriate glandular present | <u>Vandellia mollis</u> |
| 42 | Uniseriate glandular absent | |
| 43 | Unicellular hooked present | <u>Eutima glandulosa</u> |
| 43 | Unicellular hooked absent | <u>Nemesia strumosa</u> |
| 40 | Bicellular glandular capitate absent | |
| 44 | Uniseriate aseptate flagellate present | <u>Torenia violacea</u> |
| 44 | Uniseriate aseptate flagellate absent | |
| 45 | Unicellular dentate present | |
| 46 | Bicellular conical present | <u>Torenia cordifolia</u> |
| 46 | Bicellular conical absent | <u>Mimulus gracilis</u> |
| 45 | Unicellular dentate absent | <u>Bacopa monnieri</u> |

Appendix - II contd.

39 Feltate glandular absent

47 Bicellular glandular capitate vesicular present Scrophularia decomposita esp. latifolia47 Bicellular glandular capitate vesicular absent

48 Bicellular glandular capitate present

49 Unicellular flagellate present Lindernia parviflora49 Unicellular flagellate absent Morus japonicus

48 Bicellular glandular capitate absent

50 Uniseriate hooked present Limnophila indica

50 Uniseriate hooked absent

51 Unicellular dentate present Limnophila sessiliflora51 Unicellular dentate absent Craterostigma plantigena

APPENDIX - III : TRICHOMIC KEY TO THE TAXA OF SERIES - RHINANTHIDEAE

- 1 Unicellular glandular capitate present
 - 2 Uniseriate filiform present
 - 3 Uniseriate conical present
 - 4 Uniseriate septate flagellate present
 - 5 Uniseriate glandular present
 - 6 Bicellular glandular capitate Veronica serpyllifolia
 - 6 Bicellular glandular capitate absent Veronica arvensis
 - 5 Uniseriate glandular absent
 - 7 Uniseriate cylindrical present
 - 8 Bicellular curved present Veronica persica
 - 8 Bicellular curved absent Pedicularis flammula
 - 7 Uniseriate cylindrical absent Veronica eriocarpa
 - 4 Uniseriate septate flagellate absent
 - 9 Bicellular conical present Veronica biloba
 - 9 Bicellular conical absent Pedicularis bifida
 - 3 Uniseriate conical absent
 - 10 Uniseriate glandular capitate present
 - 11 Uniseriate curved present Pedicularis pectinata var. typica
 - 11 Uniseriate curved absent Digitalis lanata
 - 10 Uniseriate glandular capitate absent
 - 12 Uniseriate septate flagellate present
 - 13 Bicellular glandular capitate present Pedicularis pectinata ssp. bipinnatifida
 - 13 Bicellular glandular capitate absent

Appendix - III contd.

- 14 Uniseriate papillose present Veronica mellissaeifolia
- 14 Uniseriate papillose absent Pedicularis asplenifolia
- 12 Uniseriate septate flagellate absent
 - 15 Uniseriate curved present Alectra sessiliflora
 - 15 Uniseriate curved absent
 - 16 Bicellular hooked present Centranthera nepalensis
 - 16 Bicellular hooked absent Buchnera himalaica
- 2 Uniseriate filiform absent
 - 17 Uniseriate glandular capitate present
 - 18 Bicellular glandular capitate present Pedicularis verticillata
 - 18 Bicellular glandular capitate absent
 - 19 Uniseriate septate flagellate present Wulfsenia antheratiana
 - 19 Uniseriate septate flagellate absent Veronica verna
 - 17 Uniseriate glandular capitate absent
 - 20 Uniseriate septate flagellate present
 - 21 Bicellular acuminate present Alectra parasitica var. chitrakutensis
 - 21 Bicellular acuminate absent Alectra indica
 - 20 Uniseriate septate flagellate absent
 - 22 Bicellular glandular capitate vesicular present Euphrasia officinalis
 - 22 Bicellular glandular capitate vesicular absent
 - 23 Uniseriate glandular capitate vesicular present Sorubia delphinifolia
 - 23 Uniseriate glandular capitate vesicular absent
 - 24 Uniseriate glandular present Veronica undulata
 - 24 Uniseriate glandular absent Veronica beccabunga

Appendix - III contd.

1 Unicellular glandular capitate absent

25 Uniseriate filiform present

26 Bicellular glandular capitate present

27 Uniseriate septate flagellate present

28 Uniseriate conical present Pedicularis plantilincii

28 Uniseriate conical absent

29 Uniseriate glandular present Pedicularis pyramidata29 Uniseriate glandular absent Pedicularis brevifolia27 Uniseriate septate flagellate absent Digitalis purpurea

26 Bicellular glandular capitate absent

30 Peltate glandular present Hemiphragma heterophyllum30 Peltate glandular absent Pedicularis oderi

25 Uniseriate filiform absent

31 Uniseriate glandular capitate present

32 Uniseriate aseptate flagellate present Euphrasia /ava32 Uniseriate aseptate flagellate absent Euphrasia ineschkei

31 Uniseriate glandular capitate absent

33 Bicellular aseptate flagellate present

34 Peltate glandular present Striga eufhrasioides34 Peltate glandular absent Striga orobanchoides

33 Bicellular aseptate flagellate absent

35 Bicellular glandular capitate present Scrophia trifida

35 Bicellular glandular capitate absent

36 Uniseriate conical present Striga lutea

36 Uniseriate conical absent

37 Peltate porous glandular present Scoperia dulcis

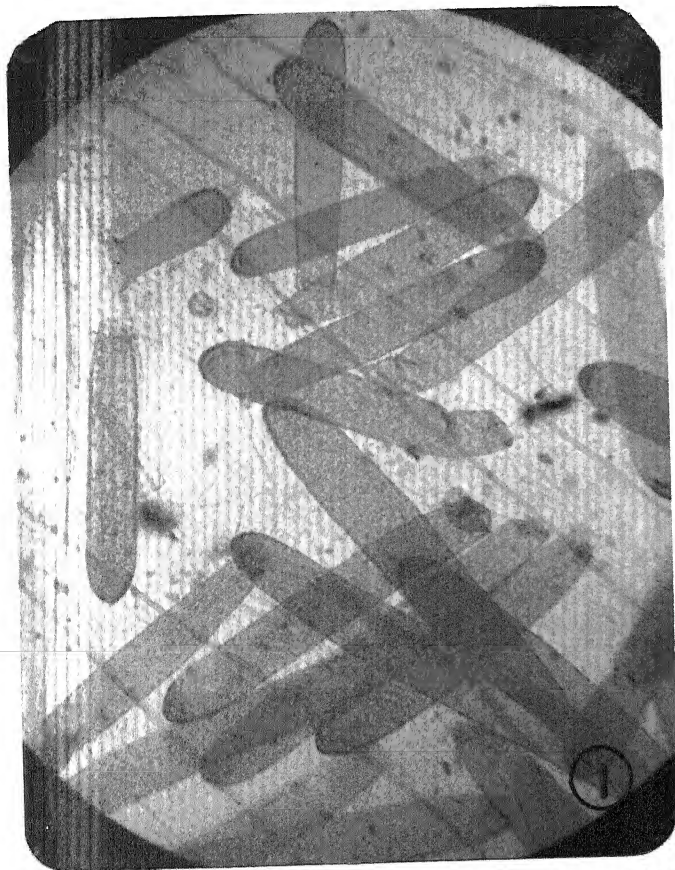
37 Peltate porous glandular absent

38 Unicellular papillose present Veronica acroestis38 Unicellular papillose absent Veronica anacaliscaquatica

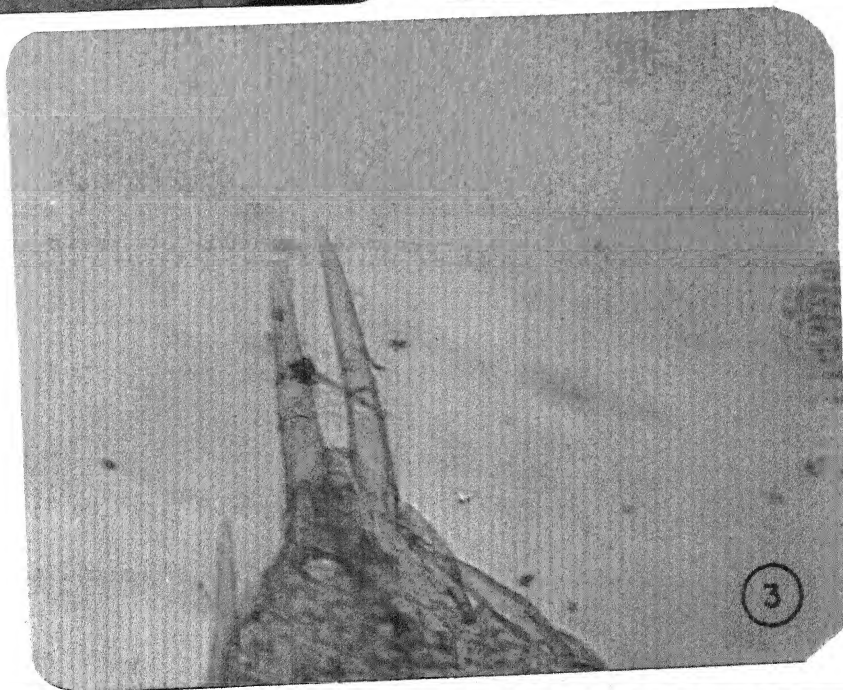
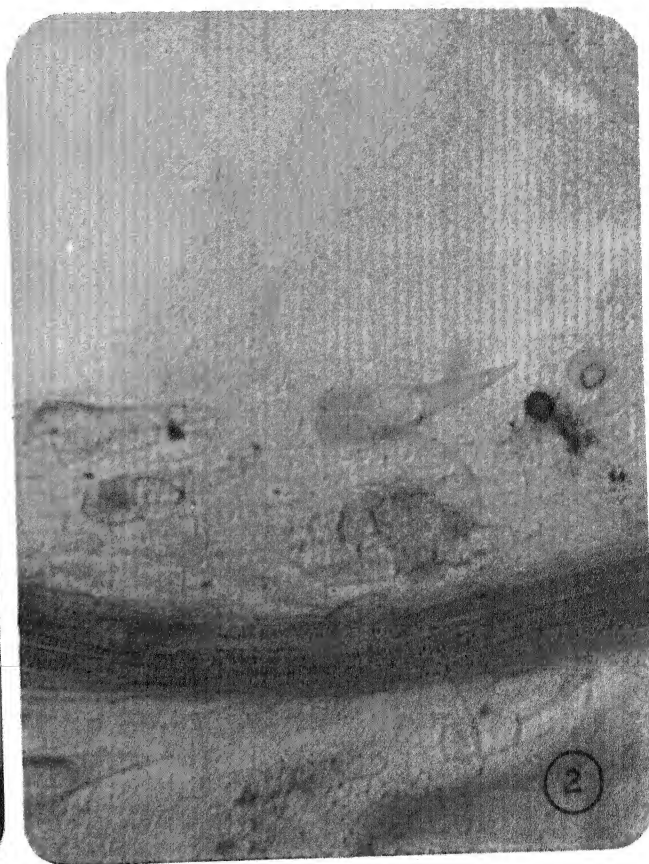
PHOTOPLATES

PLATE-52

Unicellular cylindrical

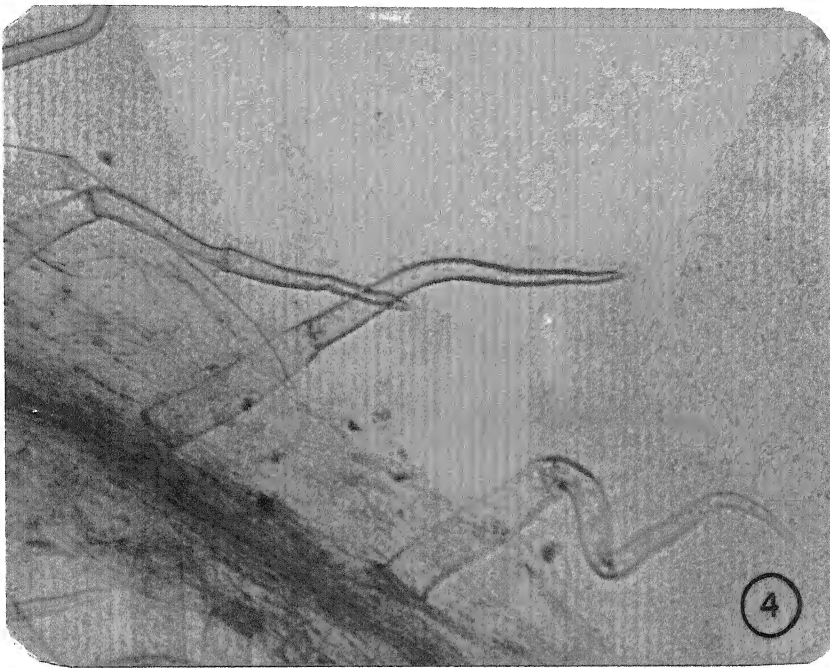


Unicellular conical



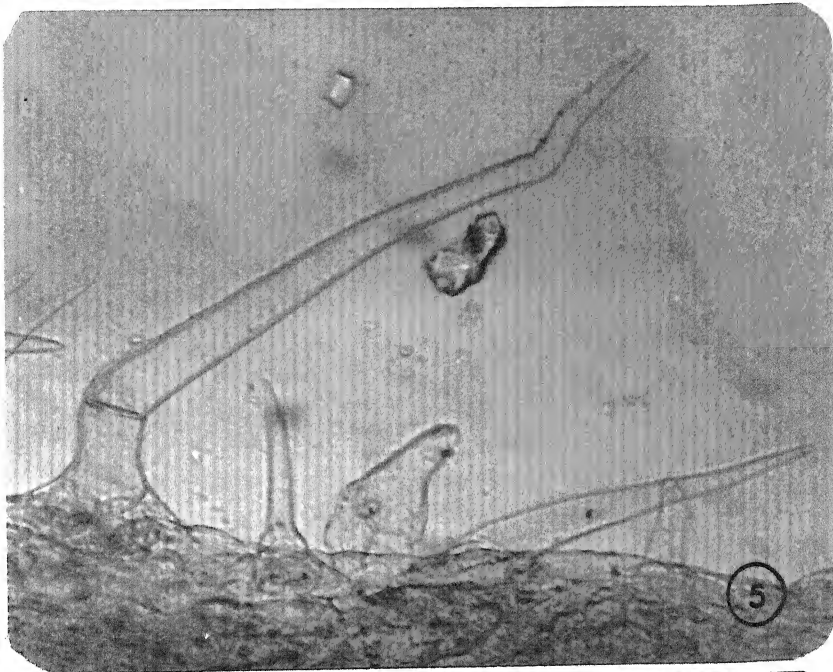
Bicellular conical

PLATE-53



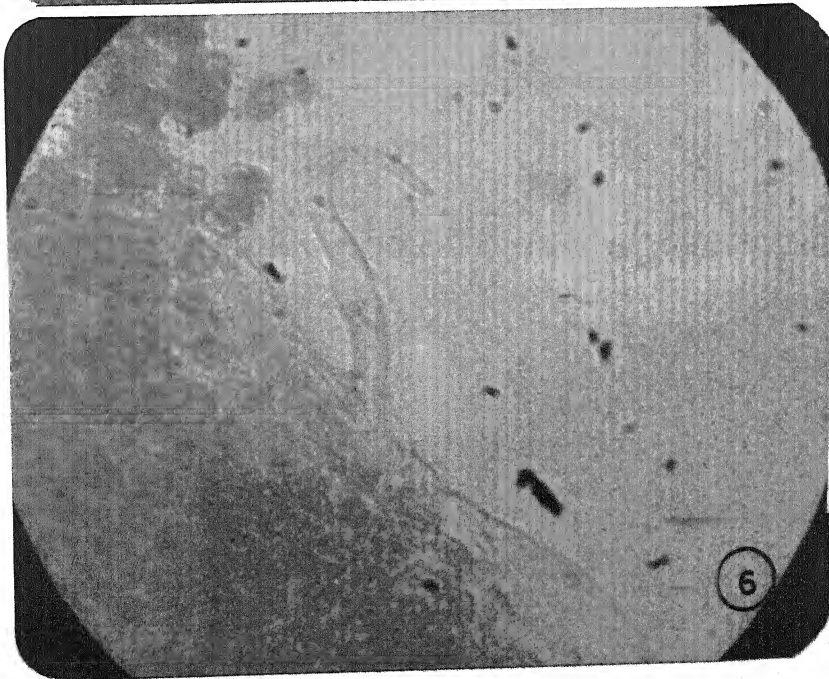
acellular asoptate
stagnellate

4



acellular asoptate
stagnellate

5



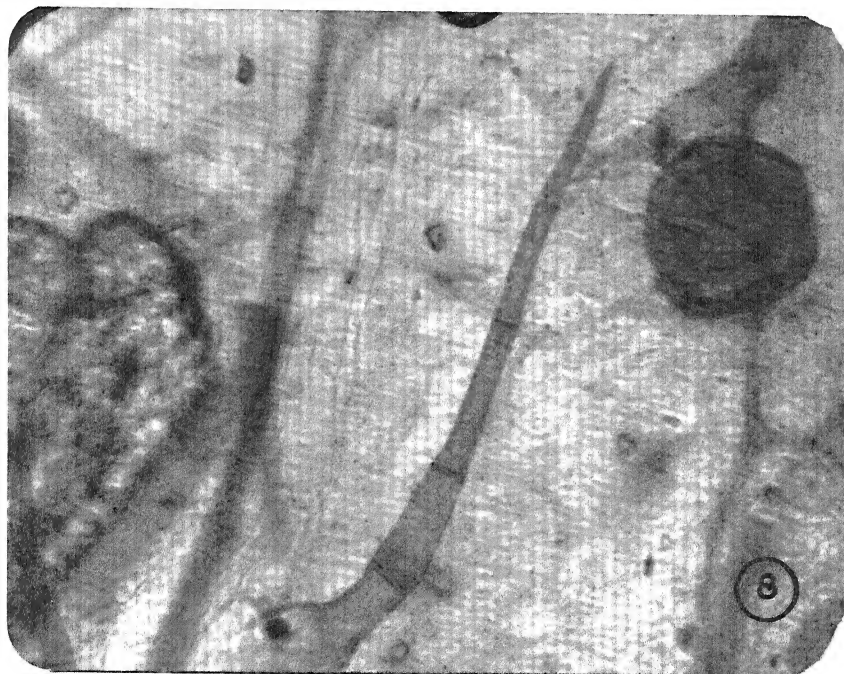
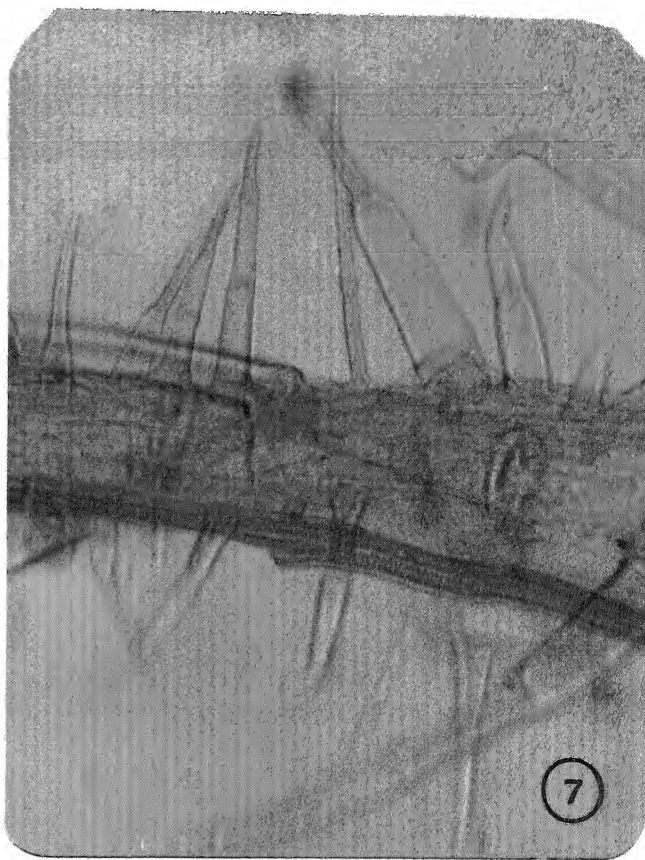
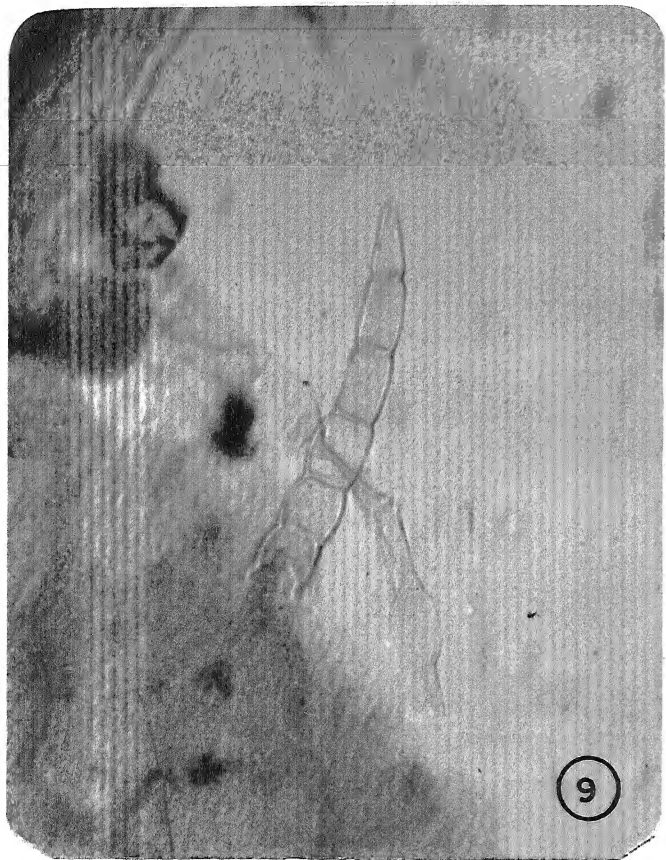
acellular asoptate
stagnellate

6

Uniseriate conical

PLATE-54

Uniseriate acuminate

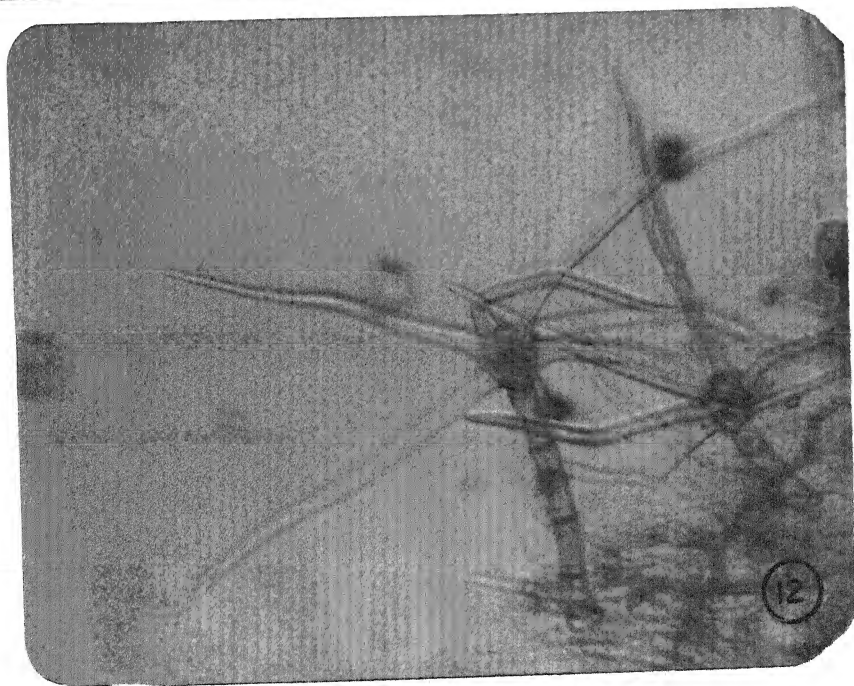
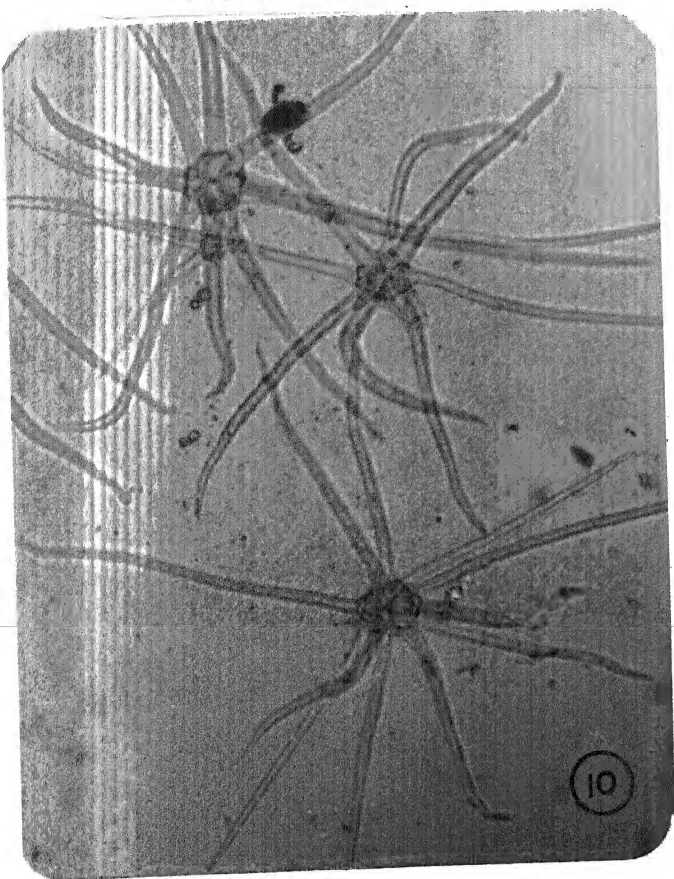


Uniseriate filiform

Sessile stellate
multiradiate

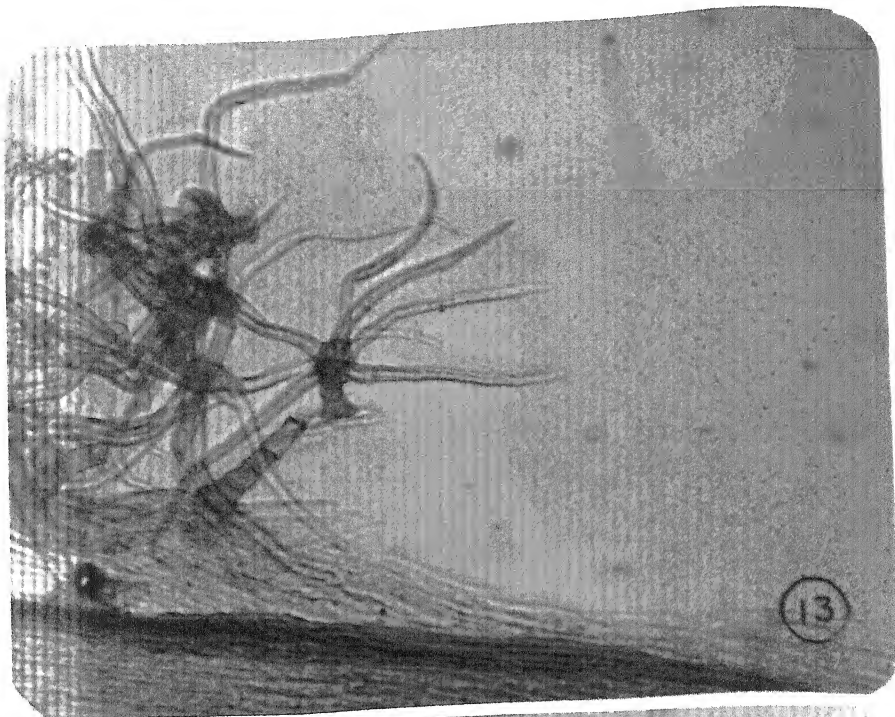
PLATE-55

Sessile stellate
multiradiate

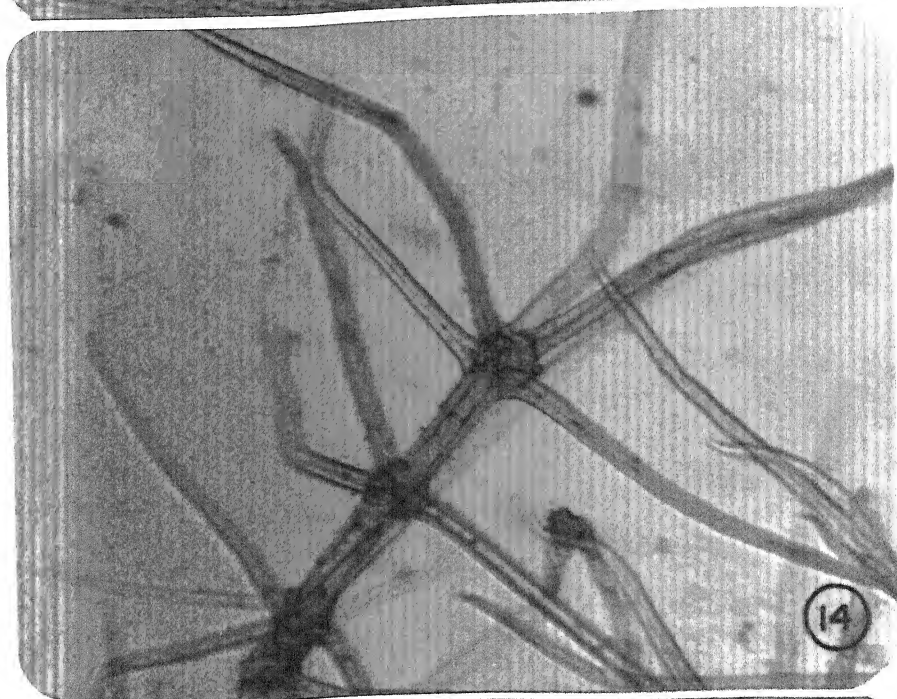


Stalked stellate multiradiate

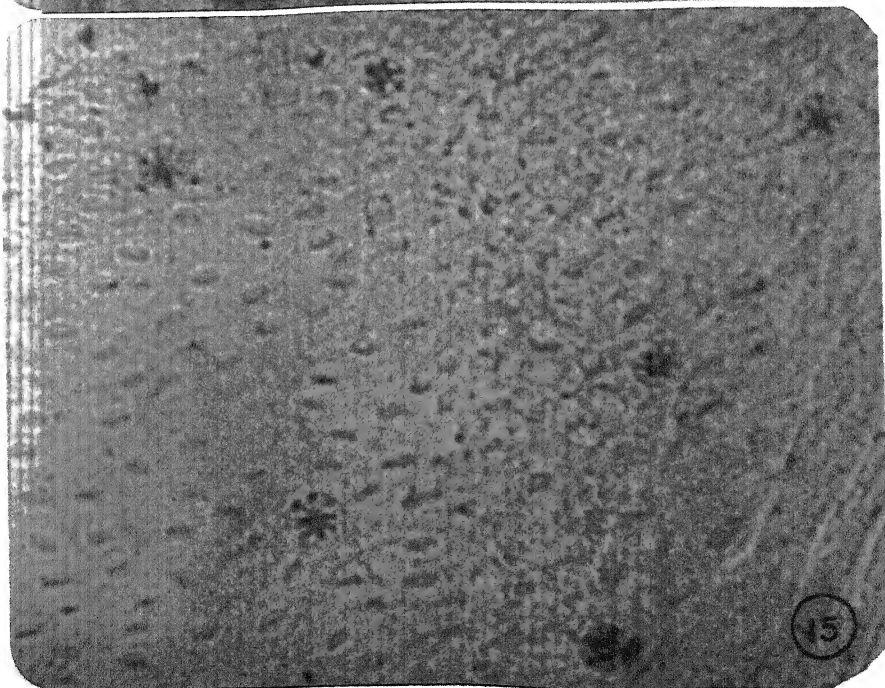
Stalhus stellatus
multiradiatus



Dendroia



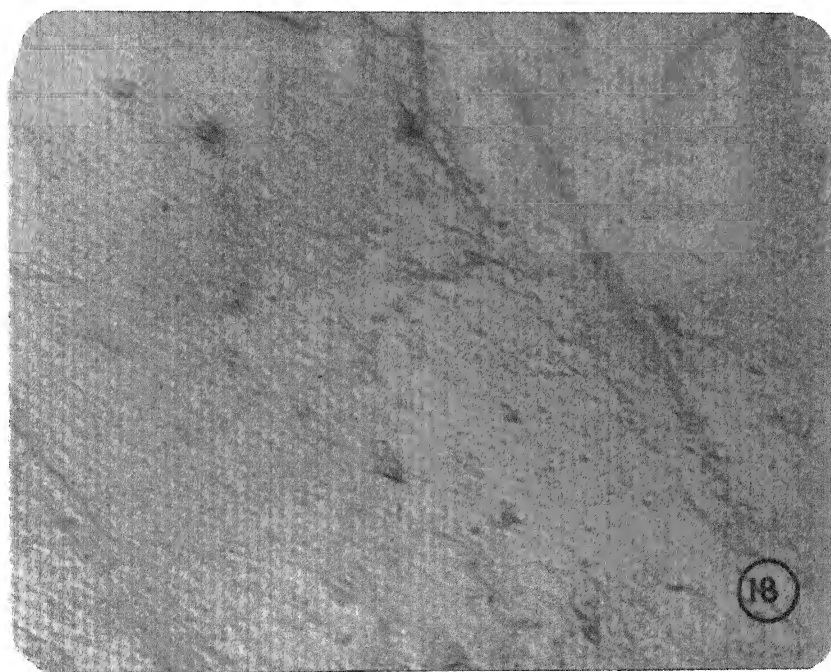
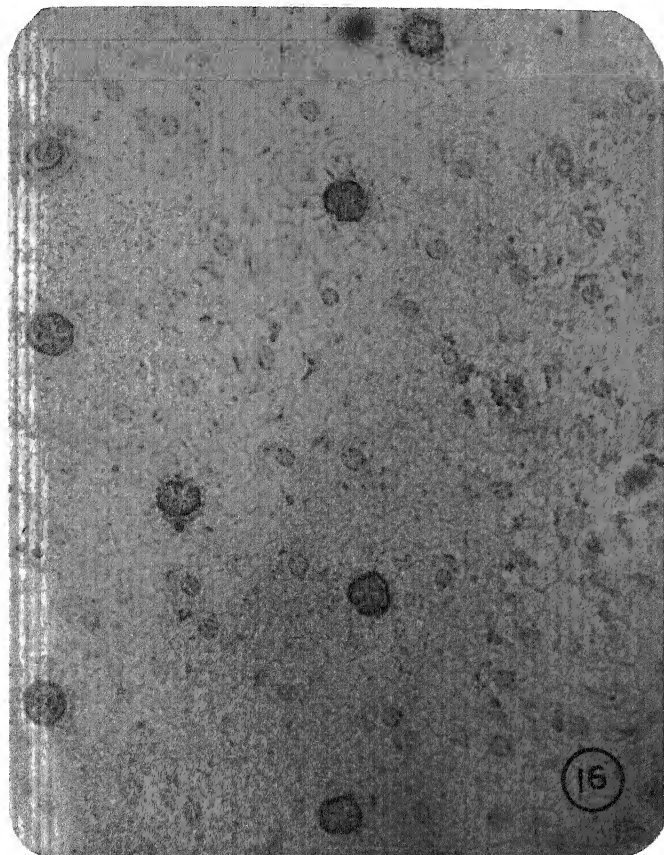
Peltate porus glandular



Peltate glandular

PLATE-57

Peltate glandular
vesicular

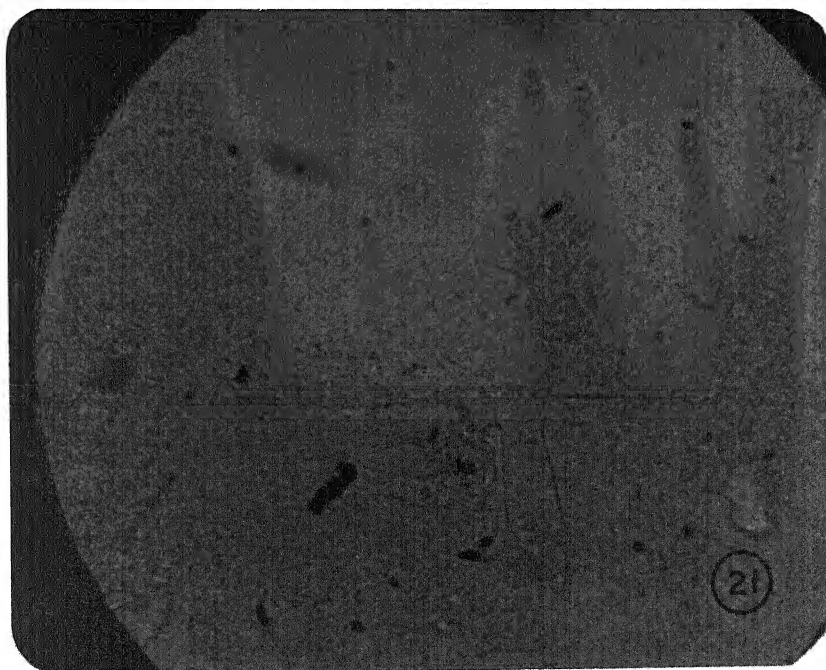
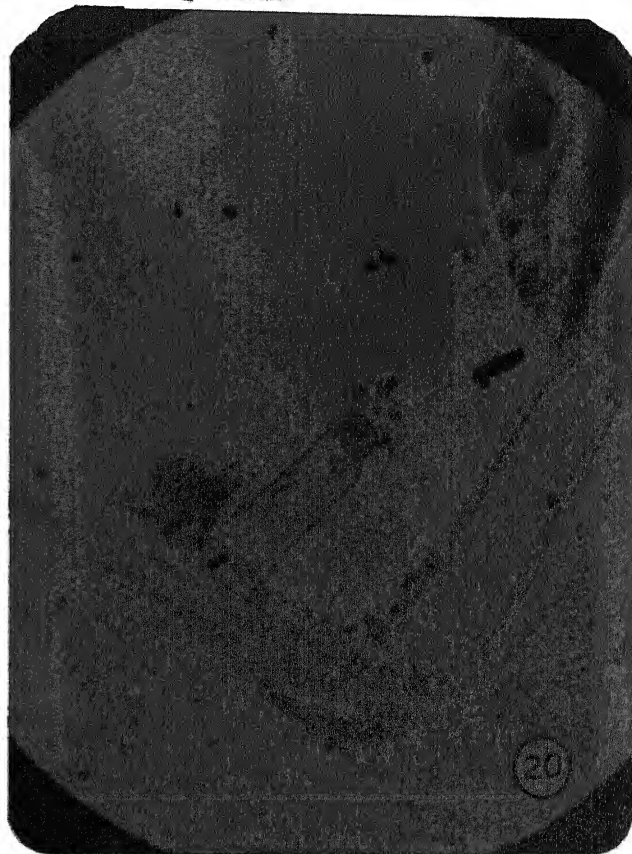
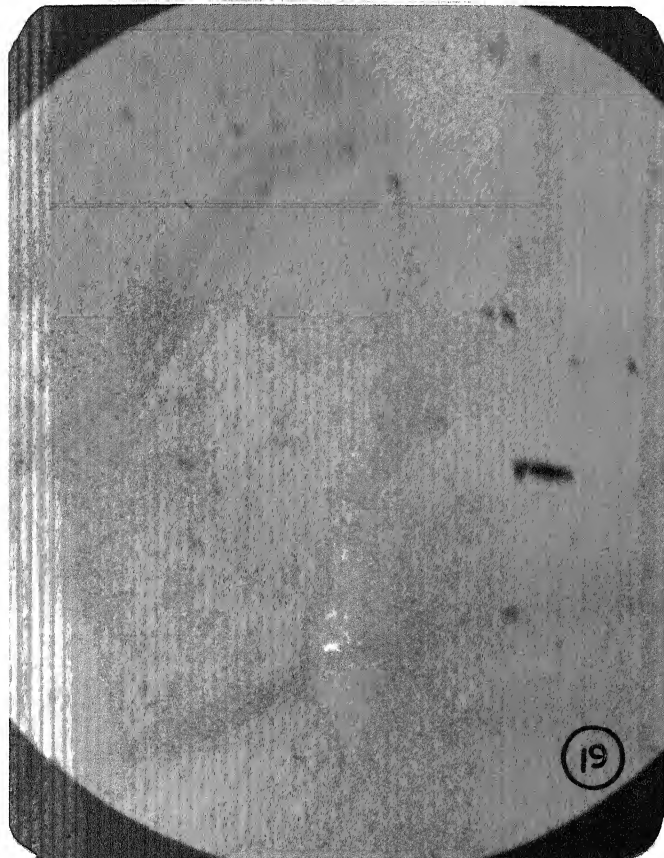


Unicellular glandular
capitate

Unicellular glandular
capitate

PLATE-58

Bicellular glandular
capitate

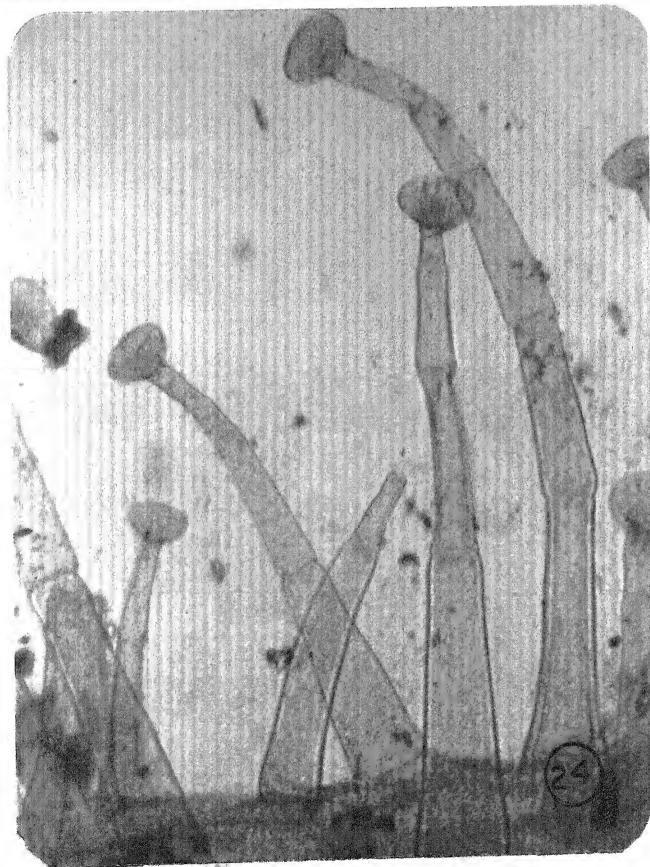
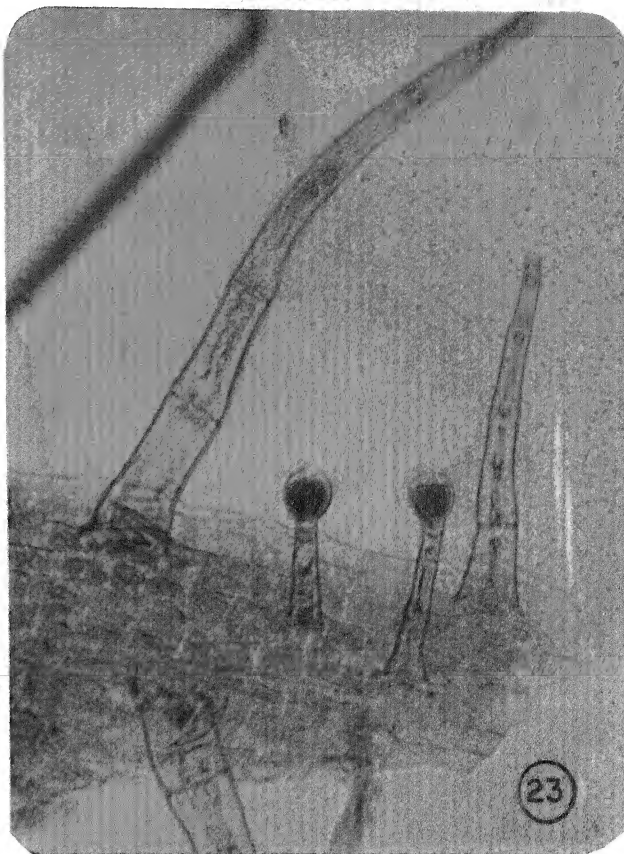
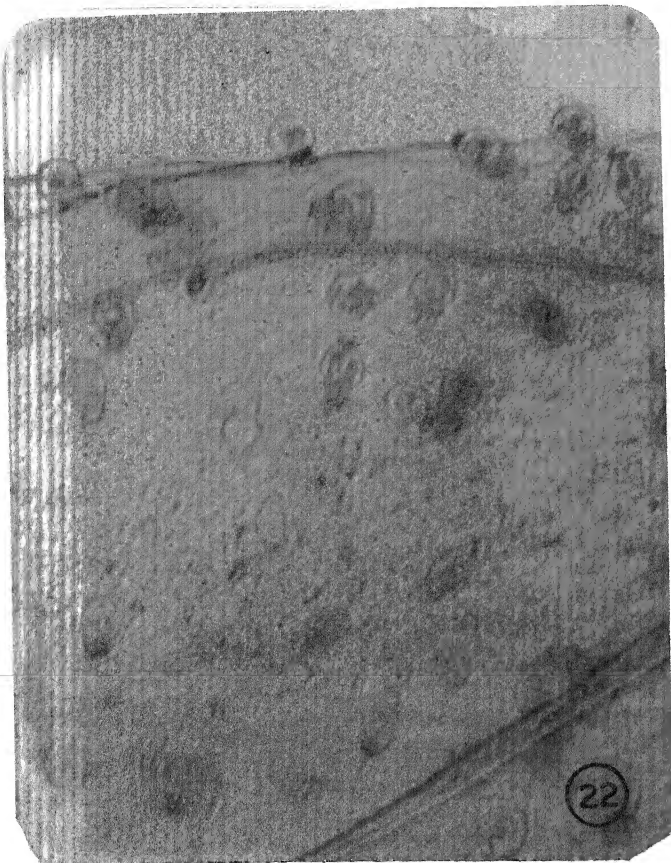


Bicellular glandular capitate

Bicellular glandular
capitate

PLATE-59

Uniseriate glandular
capitate

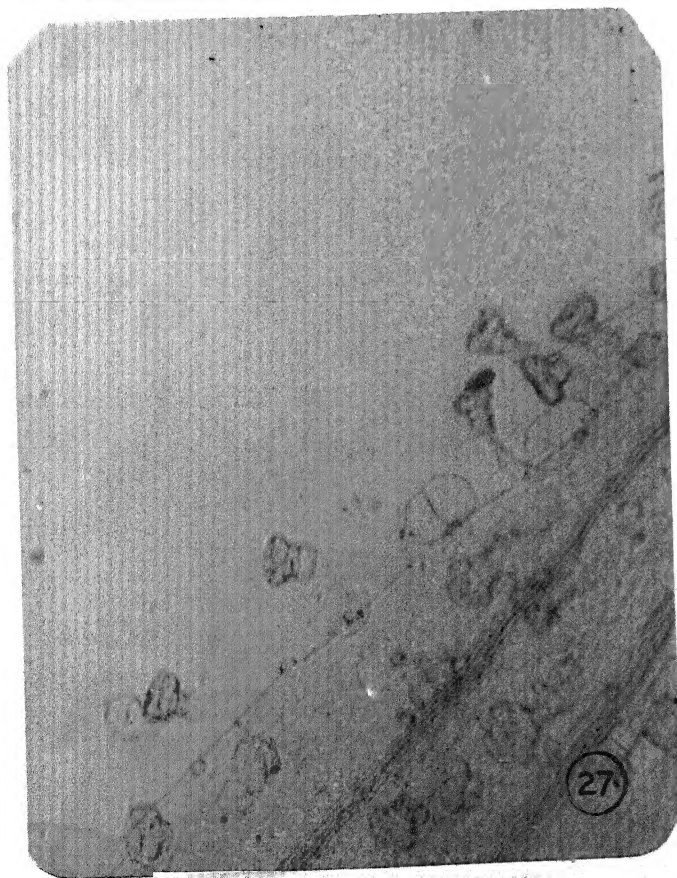
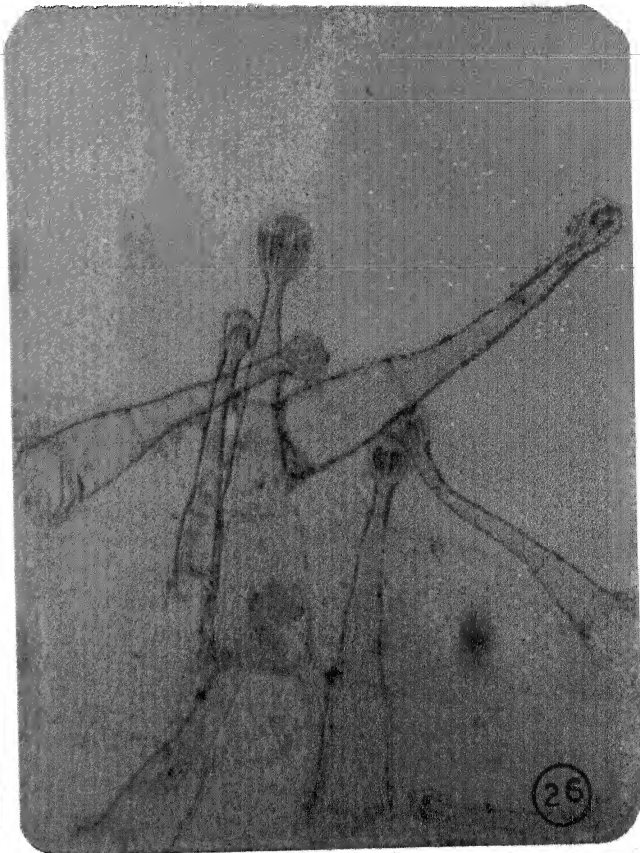
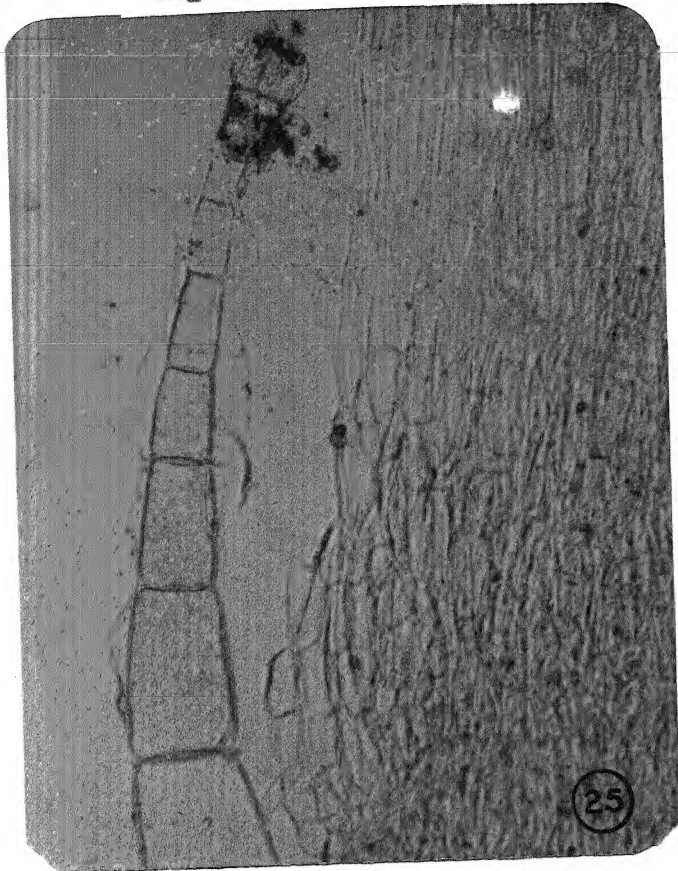


Uniseriate glandular
capitate

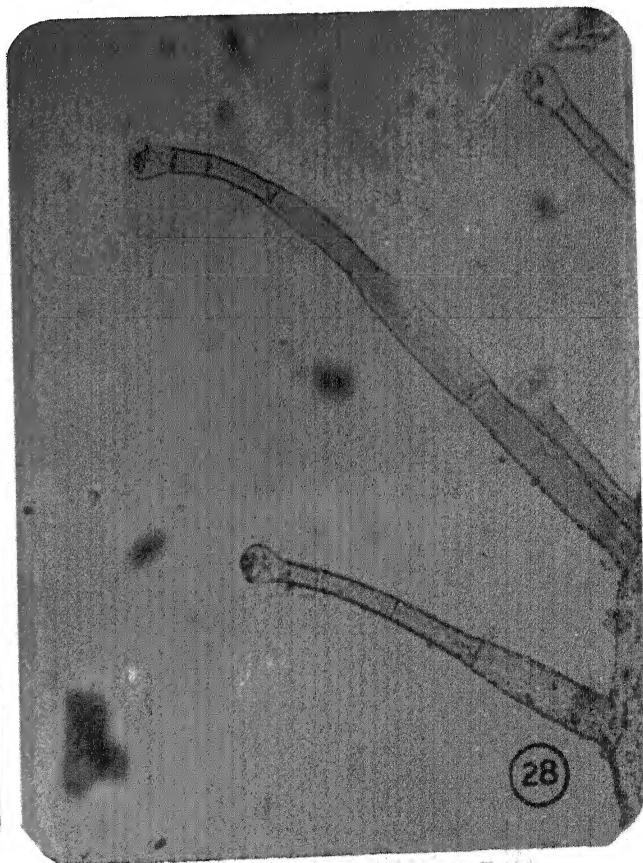
uniseriate glandular
capitate

PLATE-60

Uniseriate glandular
capitate



Brevicollate glandular
capitate



uniseriate glandular
capitate